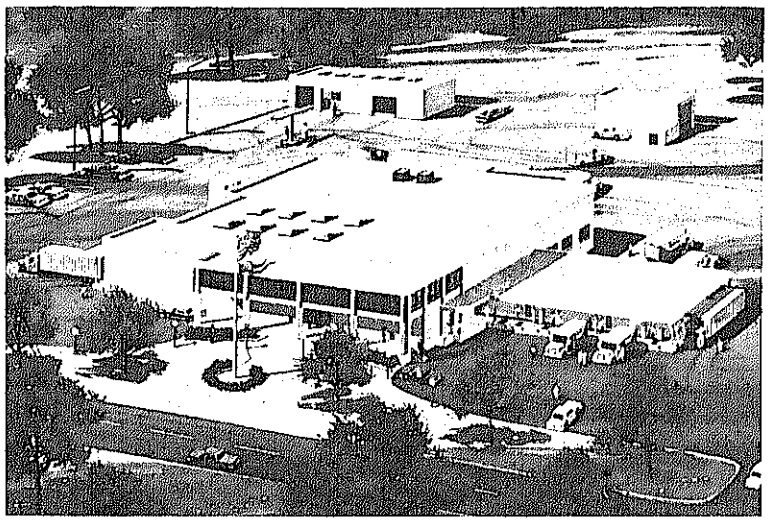
COMPARATIVE ANALYSIS OF A REMODELED VERSUS A NEW DAIRY PRODUCTS PROCESSING PLANT



UNITED STATES DEPARTMENT OF AGRICULTURE

MARKETING RESEARCH REPORT NUMBER 1086

PREPARED BY SCIENCE AND EDUCATION ADMINISTRATION

On January 24, 1978, four USDA agencies—Agricultural Research Service (ARS), Cooperative State Research Service (CSRS), Extension Service (ES), and the National Agricultural Library (NAL)—merged to become a new organization, the Science and Education Administration (SEA), U.S. Department of Agriculture.

This publication was prepared by the Science and Education Administration's Federal Research staff, which was formerly the Agricultural Research Service.

PREFACE

This report provides information to aid dairy plant operators in improving their facilities and operating methods and shows how such improvements can affect production labor cost. Layout plans are included for remodeling an existing plant and for constructing new facilities.

Appreciation is extended to the dairy firm whose facilities and operations provided the basic data used in developing the information in this report.

This study was conducted under the general supervision of T. F. Webb, Chief, Animal Products Marketing Laboratory, Science and Education Administration.

CONTENTS

	Page
Summary	1
Introduction	2
Description and evaluation of existing facilities	3
Overall design	3
Volume and type of products processed and handled	6
Plant operations	6
Deficiencies in existing facilities	11
Alternatives for satisfying facility requirements	12
Description and evaluation of remodeled facilities	14
Plant operations requiring change	15
Limitations of remodeled facilities	18
Description and evaluation of new facilities	18
Overall design	18
Facilities arrangement on the site	21
Plant operations	21
Labor analysis, investment costs, and potential benefits	29
Remodeled facilities	29
New facilities	32
Conclusions	33
Appendix	34
Part I – Labor requirements for handling present volume in remodeled facilities	34
Part II – Labor requirements for handling future volume in remodeled facilities	37
Part III – Labor requirements for handling future volume in new facilities	42

Cover illustration.—Artist's conception of proposed new dairy products processing plant.

Washington, D.C.

Issued May 1978

Comparative Analysis of a Remodeled Versus a New Dairy Products Processing Plant

By CHARLES F. STEWART, *agricultural marketing specialist*[1]

SUMMARY

· of the facilities used to process and lairy products are rapidly becoming ob- ›ecause of inefficient operating proce- nd inadequate space for expansion. To th these and other problems, plant op- must decide whether to remodel their ›r build new facilities. This report pro- formation, based on 1976 data, to aid ant operators in improving their facil- d operating methods and shows how provements can affect production labor ncludes a detailed description and eval- ›f an actual dairy products processing he remodeling changes needed to effi- ›rocess and handle a 50-percent increase resent volume, and information on con- g new facilities to handle the same in- ı volume. A comparison of the estimated quirements, investment costs, and po- benefits is provided for each of the ive development stages, along with lay- remodeling the existing plant and con- g new facilities.

etailed evaluation of the existing plant hat the production labor cost for proc- nd handling the present volume could ed by $23,270 annually by rescheduling gnments and adopting new operating res. By remodeling the existing plant to process and handle a 50-percent increase in the present volume, the production labor cost could be reduced by $65,140 annually, with an investment of only $35,000. The reduced labor cost is attributed to the increased productivity per man-hour of labor in handling the greater volume, whereas the investment cost primarily includes the modification or purchase of new equipment. Since less than a year is required to amortize the total investment cost using the accrued labor savings, remodeling the existing plant is highly feasible. However, the remodeled facilities do not provide growth capability in excess of 50 percent of the present volume because of restrictions at the present site.

The new facilities are developed not only to efficiently process and handle the 50-percent increase in present volume but more importantly to eliminate those problems which contribute to operational inefficiencies that could not be corrected in the remodeled facilities without making major changes involving an unrealistic cost. A reduction of $90,585 annually in the production labor cost is achieved in the new facilities. This is also attributed to the increased productivity per man-hour of labor in handling the greater volume. However, because of the high cost of land and construction, approximately 18 years are required to amortize the net investment cost of the new facilities ($2,339,705), using the accrued labor savings and increased revenue from additional sales.

ıltural Marketing Research Institute, Belts- ·icultural Research Center, Beltsville, Md.

INTRODUCTION

The facilities and operating methods used in processing and handling dairy products largely determine the cost of these products to the consumer. Therefore dairy plant operators must constantly reevaluate their operations so that products are processed at the lowest possible cost. This is essential because of the narrow profit margins and vigorous competition in the dairy industry.

Technological changes that have an impact on operating efficiency are occurring in the industry so rapidly that plant operators are having difficulty keeping their facilities and operating methods attuned to the changing times. Such changes include the introduction of new products, improved processing and handling equipment, new packaging equipment and containers, and improved waste-handling procedures. Increasing production without proper planning also has a major impact on operating efficiency, particularly where the volume processed and handled exceeds the optimum operating level and the designed capacity of the plant. This factor is primarily responsible for the large number of highly congested and crowded dairy plants. Because of the technological changes, the increasing production without proper planning, and other problems contributing to poor efficiency, many of the present facilities are rapidly becoming obsolete. If the industry is to continue processing an adequate supply of high quality products at a reasonable and competitive cost, maximum plant operating efficiency must be maintained.

There are approximately 4,537 dairy products processing plants in the United States, of which 2,476 process and handle fluid milk products, ice cream and other frozen desserts, and cottage cheese.[2] Many of these plants are in old single-story and multistory buildings located in highly congested commercial and residential areas with little or no space for expansion. They are poorly designed and equipped, have inadequate flow patterns for products and supplies, and utilize inefficient work methods, which result in low productivity and high operating costs. These and other problems exist in most of the older and also in many of the newer facilities. However, they are usually more severe in the older plants because they have been exposed to more changes in the industry and have been expanded numerous times to accommodate increasing growth by adding floorspace wherever possible, regardless of the effect on operating efficiency. To correct these and other problems and to provide for future growth, plant operators must decide whether to remodel their plants or build new facilities.

The purpose of this study is to provide information, based on 1976 data, to aid dairy plant operators in improving their facilities and operating methods and to show how such improvements can affect production labor cost. Production labor was selected for in-depth analysis because it represents one of the major costs in processing and handling dairy products and is where the greatest savings are possible. An actual dairy products processing plant, typical of many others in the industry, was selected for study. It provides the basic data needed for comparing the following alternatives available to plant operators for improving their facilities and operations and for accommodating future growth:

- Evaluate existing facilities and determine changes needed to efficiently handle the present volume.
- Remodel existing facilities to efficiently handle a 50-percent increase in the present volume.
- Build new facilities to efficiently handle the 50-percent increase in present volume.

In this report, estimated labor requirements, investment costs, and potential benefits are determined for each of these alternatives. Layouts are provided along with detailed descriptions of the existing, remodeled, and new facilities.

[2] U.S. Department of Commerce, Bureau of the Census, 1972 Census of Manufacturers, Industry Series. Issued February 1974.

DESCRIPTION AND EVALUATION OF EXISTING FACILITIES

Overall Design

The existing facilities, including the processing plant and several other buildings, are in a commercially zoned area near a downtown business district. The site is bounded by city streets on three sides and a redevelopment area on the other side (fig. 1). The processing plant is a two-story, steel reinforced brick and masonry structure, with the processing operations on the first floor and the administrative offices and some storage on the second. It is nearly square, with approximately 16,630 square feet on the first floor and 6,855 on the second floor. Only about 1,000 square feet of the second floor are used for storage.

Figure 2 shows the layout and equipment arrangement of the first-floor processing operations. The plant interior is highly fragmented and composed of many rooms that have evolved from increased growth. The variable floor and ceiling height makes utilization of the available floorspace difficult. It also limits the use of mechanized equipment for the bulk handling of supplies and finished products. In some instances, critically needed floorspace for other functions is used only for access to other areas. This plus the large number of small separated rooms reduce the effective use of floorspace.

All operations directly associated with the processing activities are in the plant except receiving and storing raw milk and liquid sugar, handling of product returns, peak season storage of frozen novelties, and a major part of the storage of supplies. These operations are in separate buildings because of space restrictions in the plant. The arrangement of the individual areas provides a less-than-desirable flow pattern, which does not lend itself to obtaining maximum operating efficiency. For example, the cheese processing room is at the opposite corner of the plant from the cooler. Also, the mix processing operation is widely separated from the ice cream processing room. The storage and handling of supplies largely contribute to poor efficiency because they are scattered on different floors, both in the plant and in separate buildings, and generally they are far removed from where they are needed.

The other buildings used to support the plant operations are separated from the processing plant by public alleys and narrow driveways (fig. 1). They include a receiving shelter, a small warehouse, a maintenance shop and warehouse, a garage, and a dairy supplies storage building with an attached cold storage room. The buildings are primarily steel reinforced brick and masonry structures constructed at ground level without docks.

The receiving shelter, a single-stall drive-through facility, is relatively modern in design and across the public alley from the processing plant. It is used for receiving and storing raw milk and the liquid sugar used in processing mixes.

The small warehouse "A" is rectangular and has approximately 1,500 square feet of floorspace. It is across the public alley next to the nonplant property building and about 70 feet from the processing plant. The warehouse is used primarily for storing plastic milk containers.

The maintenance shop and warehouse "B," which adjoins the garage, is a two-story structure with approximately 4,460 square feet of space on each floor. It is across the public alley about 30 feet from the processing plant. Part of the first floor is used as a maintenance shop, and the rest of the first and all the second floor are for storing dry ingredients, packaging materials, and other miscellaneous supplies used in the processing operation.

The garage has about 9,870 square feet of floorspace and is used for servicing and parking the route trucks and other vehicles assigned to the plant. Most of the space is for parking route trucks. Another area, separated from the garage by nonplant property, is also used for parking trucks.

The dairy supplies storage warehouse "C" has two floors with a partial basement. This building has approximately 12,400 square feet

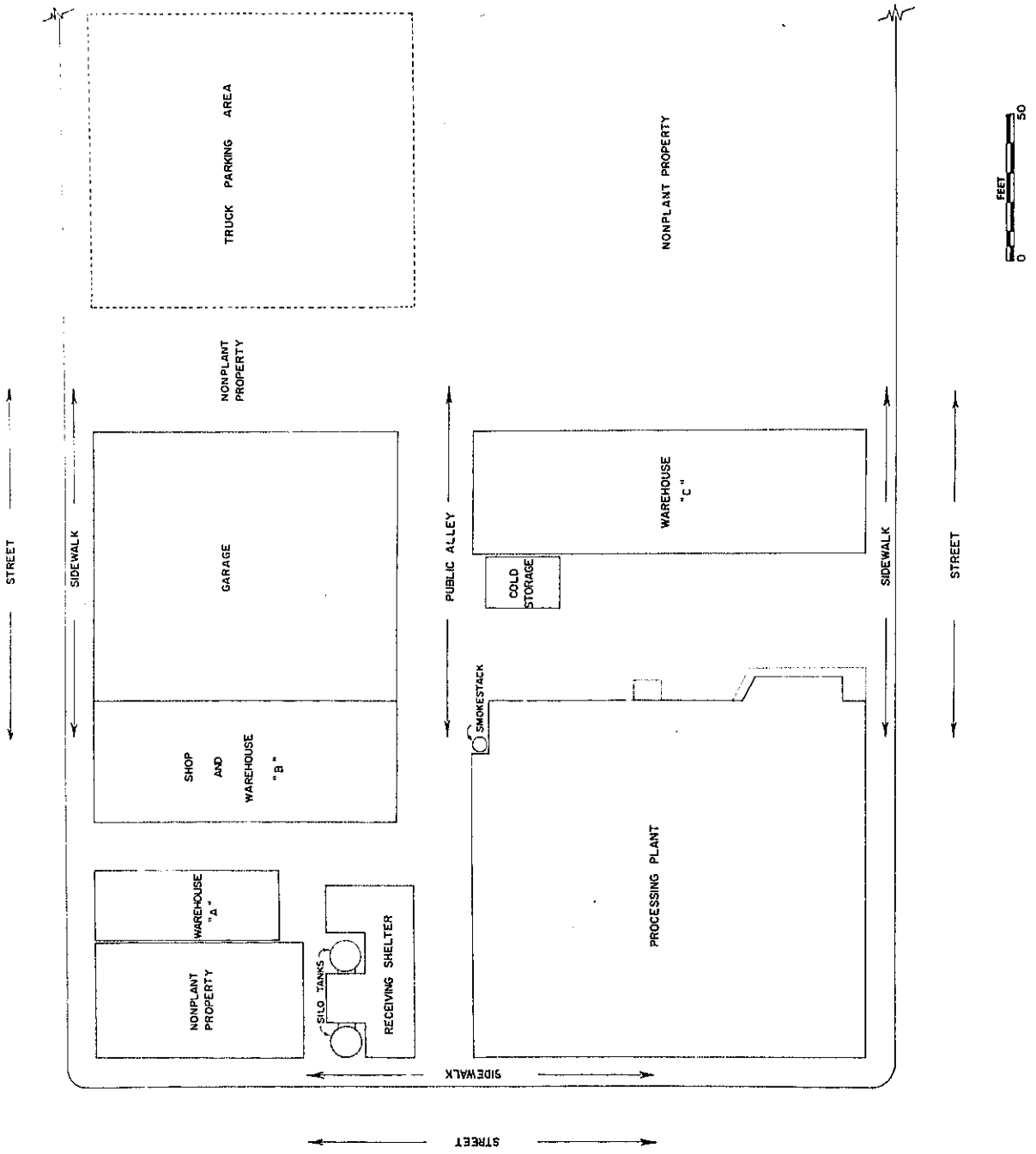


FIGURE 1.—Site plan of existing facilities.

oorspace. Only the first floor, with about 0 square feet, is used for storage. Items ed in the building include tires and other k parts, refrigeration cabinets, surplus s, and other equipment and supplies not ctly used in the processing operations. The ding is separated from the processing plant 1 50-foot-wide driveway used by most of vehicle traffic on the site. The small cold storage room attached to the building on the side next to the plant has about 485 square feet of floorspace. It is used for handling product returns and for storing novelties and other frozen items during the peak season.

Distribution facilities are in two areas approximately 40 miles from the plant, where small processing plants were converted to serve consumer needs. Finished products are trans-

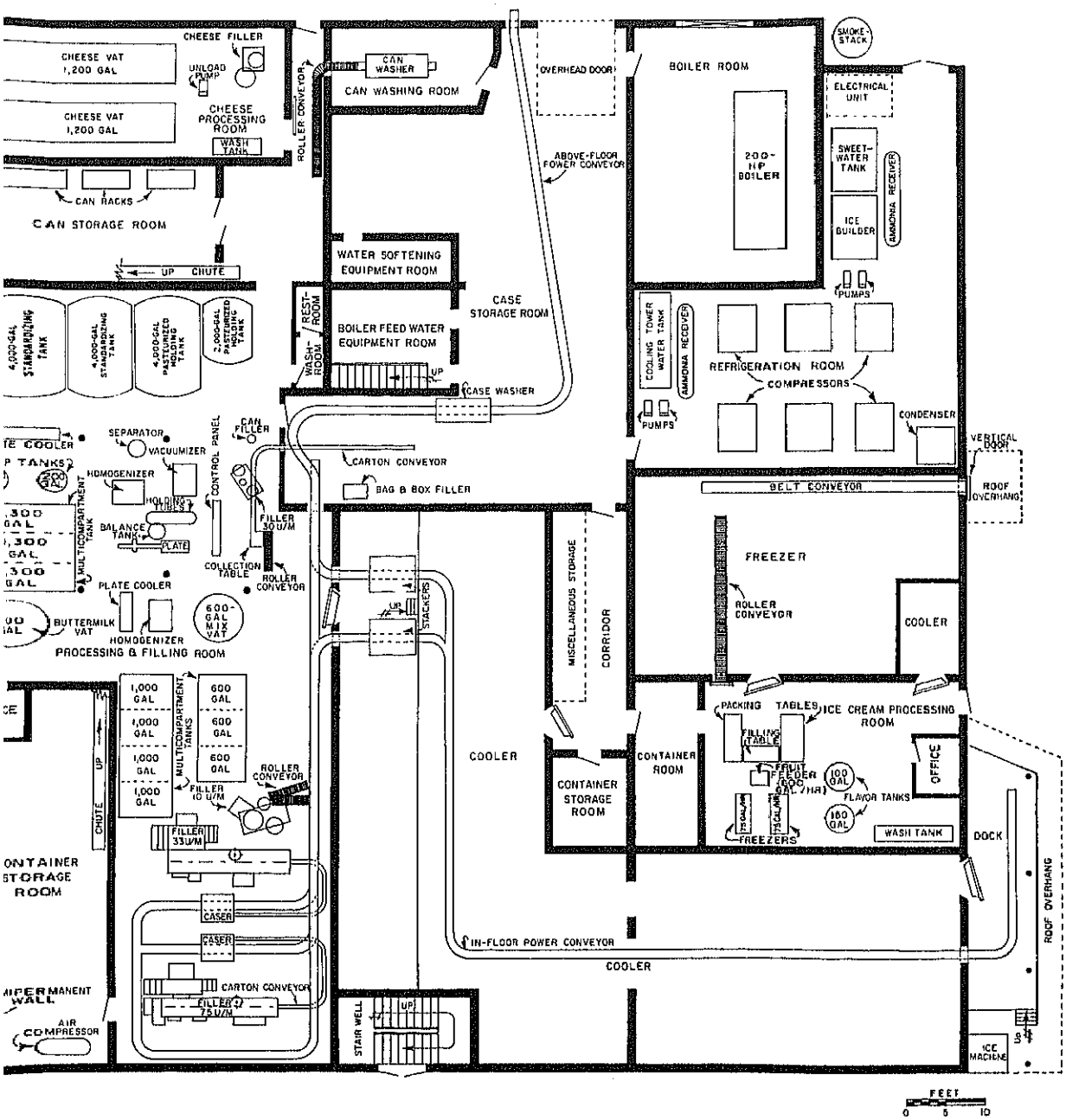


FIGURE 2.—Layout of existing plant.

ferred daily from the plant to these distribution facilities by refrigerated semitrailers and trucks with reach-in bodies.

Volume and Type of Products Processed and Handled

Based on plant production during the peak season, the volume of products processed and handled daily, 5 days a week, averages 14,929 gallons (table 1). This volume includes 12,432 gallons of fluid milk products, 307 gallons of fruit drinks, and 2,190 gallons of skim milk and cream used in processing ice cream and cottage cheese. Of the fluid milk products, approximately 92 percent is packaged in ½-pint to 1-gallon paper containers, 6 percent in 6-gallon bag and dispenser boxes, and the remaining 2 percent in 5- and 10-gallon cans. All fruit drinks are packaged in ½-gallon preformed plastic containers.

The ice cream mix is processed 6 days a week at about 448 gallons a day. Based on a 100-percent overrun factor, approximately 896 gallons of ice cream are processed daily and packaged in paper containers ranging from 5-ounce cups to 3 gallons. Packaging of the product is as follows: 2 percent in 5-ounce cups, 13 percent in pints, 5 percent in quarts, 30 percent in one-half gallons, 33 percent in gallons, and 17 percent in 3-gallon bulk cans. Approximately 7,000 gallons of frozen novelties are purchased from outside sources and maintained in inventory for distribution along with the ice cream.

Approximately 3,835 pounds of creamed cottage cheese are processed each day, 4 days a week. The cheese is packaged as follows: 45 percent in 30-ounce, 30 percent in 1-pound, and 25 percent in 5-pound paper containers, which are handled in milk cases and distributed along with the fluid milk products and fruit drinks.

Approximately 785 cases of miscellaneous products are purchased from outside sources and maintained in inventory for distribution along with the fluid milk products, fruit drinks, and cottage cheese. They include butter, margarine, eggs, cream products, yogurt, fruit juices, and low fat milk. The sour cream and low fat milk are handled in milk cases and the rest in various sizes of paper boxes.

Plant Operations

Of the total daily volume of 14,929 gallons, 12,741 gallons are processed by the high temperature, short time (HTST) method and 2,188 by the batch method. The type and volume of each product group by method are as follows:

High Temperature, Short Time Method

Product group	*Gal*
Fluid milk	10,782
Fruit drinks	307
Skim milk for cottage cheese	1,534
Cheese dressing	118
Total	12,741

Batch Method

Buttermilk	183
Soft serve mix	1,467
Ice cream mix	538
Total	2,188

The suggested schedules (tables 2–5) are used to determine the adequacy of the existing facilities and equipment for processing and handling the present volume. Raw milk receipts are scheduled to meet daily processing requirements and to minimize the holdover and inventory volume. The processing operations are scheduled so that the same volume of products is processed each day, with the volumes distributed correlated to sales. Although processing approximately the same volume of products each day is desirable, the schedule may need to be modified because of equipment limitations and the processing of small volumes of certain products. The volume of finished product holdover is kept to a minimum, but enough products are held in storage at all times to meet sales needs. The processing and filling operations are scheduled to minimize the volume of pasteurized product hold. A balance between the processing and filling rates is desirable; however, a difference in rates can be compensated for by adjusting the starting times of each operation and having adequate storage capacity.

The batch processing vats and the tanks used for blending and storing products are selected

on the basis of the daily volume processed, with the operations scheduled to obtain maximum utilization of labor and equipment. The filling equipment is selected (1) to meet consumer packaging demands and (2) to obtain to the extent possible balanced filling times of each machine, with the total filling and processing rates approximately the same.

Receiving

The receiving shelter for raw milk is adequate to meet present needs. However, by being separated from the plant, it is inconvenient and restricts the cross-utilization of labor between the receiving and processing operations. The maximum volume of raw milk inventory is 10,-

TABLE 1.—*Average daily volume of fluid products processed and packaged by size and type of container during peak production*

Product	Total volume (gal)	Container size	Type of container							
			Paper		Dispenser box		Bulk can		Plastic	
			Units	Gallons	Units	Gallons	Units	Gallons	Units	Gallons
Homogenized milk	384	6 gal	-----	-----	64	384	--	---	---	---
	40	10 gal	-----	-----	---	---	4	40	---	---
	2,548	1 gal	2,548	2,548	---	---	--	---	---	---
	2,822	½ gal	5,644	2,822	---	---	--	---	---	---
	221	1 qt	884	221	---	---	--	---	---	---
	180	⅓ qt	2,160	180	---	---	--	---	---	---
	1,108	½ pt	17,728	1,108	---	---	--	---	---	---
Skim milk, 2 percent	312	6 gal	-----	-----	52	312	--	---	---	---
	355	1 gal	355	355	---	---	--	---	---	---
	1,490	½ gal	2,980	1,490	---	---	--	---	---	---
Skim milk	60	6 gal	-----	-----	10	60	--	---	---	---
	171	½ gal	342	171	---	---	--	---	---	---
	108	1 qt	432	108	---	---	--	---	---	---
	28	½ pt	448	28	---	---	--	---	---	---
Chocolate milk	36	6 gal	-----	-----	6	36	--	---	---	---
	78	½ gal	156	78	---	---	--	---	---	---
	70	1 qt	280	70	---	---	--	---	---	---
	64	⅓ qt	768	64	---	---	--	---	---	---
	614	½ pt	9,824	614	---	---	--	---	---	---
Buttermilk	114	½ gal	228	114	---	---	--	---	---	---
	51	1 qt	204	51	---	---	--	---	---	---
	11	⅓ qt	132	11	---	---	--	---	---	---
	7	½ pt	112	7	---	---	--	---	---	---
Half and half	17	1 qt	68	17	---	---	--	---	---	---
	76	1 pt	608	76	---	---	--	---	---	---
Soft serve mix	175	5 gal	-----	-----	---	---	35	175	---	---
	377	1 gal	377	377	---	---	--	---	---	---
	915	½ gal	1,830	915	---	---	--	---	---	---
Subtotal	12,432	------	48,108	11,425	132	792	39	215	---	---
Fruit drinks	307	½ gal	-----	-----	---	---	--	---	614	307
Ice cream mix	538	------	-----	-----	---	---	--	---	---	---
Skim milk for cottage cheese	1,534	------	-----	-----	---	---	--	---	---	---
Cheese dressing	118	------	-----	-----	---	---	--	---	---	---
Subtotal	[1] 2,190	------	-----	-----	---	---	--	---	---	---
Grand total	14,929	------	48,108	11,425	132	792	39	215	614	307

[1] Volume used in processing ice cream and cottage cheese.

TABLE 2.—*Suggested daily schedule for processing, handling, and distributing present volume of fluid milk products and fruit drinks*

Item	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	Gal	*Gal*	*Gal*	*Gal*	*Gal*	*Gal*	*Gal*
Raw milk inventory	9,748	4,874	0	10,966	7,310	3,655	9,748
Raw milk receipts	9,748	9,748	10,966	10,966	10,967	10,967	9,748
Processed milk products	12,432	12,432	0	12,432	12,432	12,432	0
Milk for manufacturing purposes	2,190	2,190	0	2,190	2,190	2,190	0
Raw milk holdover	4,874	0	10,966	7,310	3,655	0	9,748
Processed fruit drinks	307	307	0	307	307	307	0
Sales - distribution:							
Milk products	11,810	11,810	6,216	9,946	11,810	10,568	0
Fruit drinks	292	292	154	245	292	260	0
Finished product holdover	15,924	16,561	10,191	12,739	13,376	15,287	15,287

966 gallons (table 2). Since two 12,000-gallon silo tanks are available for storing raw milk, no additional capacity is required. The 6,000-gallon sugar tank housed in the receiving shelter is adequate for storing the liquid sugar needed in processing ice cream and soft serve mixes. However, it only provides storage for one type of sweetener, whereas other sweeteners might be desirable for concurrent use.

Processing

The processing area is somewhat crowded and congested with all the equipment needed to conduct the operations. The two 4,000-gallon standardizing tanks have sufficient capacity to handle the average daily volume (7,303 gal) of homogenized milk (table 1). The high temperature, short time processing unit (2,095 gallons per hour at 90-percent efficiency) is capable of processing 12,741 gallons in 6 hours and 5 minutes. The schedule for processing and filling shown in table 3 allows both operations to begin simultaneously and limits the pasteurized product hold to a maximum of 3,438 gallons. Since the processing rate is greater than the filling rate, storage capacity is required for holding a larger volume buildup of pasteurized product. Although the rates should be more evenly balanced, the 2,000- and 4,000-gallon pasteurized holding tanks have sufficient storage capacity to handle the maximum product hold and provide separate storage for the homogenized and the 2-percent skim milk.

TABLE 3.—*Suggested hourly schedule for processing and filling present volume of products based on high temperature, short time processing rate*

Schedule (hours)	Processing rate per hour [1]	Filling rate per hour [2]	Pasteurized product hold
	Gal	*Gal*	*Gal*
1st	2,095	1,522	573
2d	2,095	1,522	1,146
3d	2,095	1,522	1,719
4th	2,095	1,522	2,292
5th	2,095	1,522	2,865
6th	2,095	1,522	[3] 3,438
7th (5 min)	169	1,522	2,085
8th	0	[4] 1,078	[5] 1,007
Total	12,739	11,732	-----

[1] At 90-percent efficiency.
[2] At 80-percent efficiency.
[3] Maximum volume of pasteurized product hold.
[4] 8th-hour filling schedule (43 min).
[5] Volume filled in dispenser boxes and bulk cans.

The two 600-gallon batch processors used for buttermilk and for the ice cream and soft serve mixes are adequate for present needs, even though three vats of ice cream and soft serve mixes must be prepared each processing day (table 4). The multicompartment tank with three 600-gallon compartments is adequate for storing the pasteurized ice cream mix, a part of the soft serve mix, and the 40-percent cream. Most of the soft serve mix is stored in one of the four 1,000-gallon compartments of the mul-

TABLE 4.—*Size and number of vats or tanks required for processing and storing present volume of fluid milk products and fruit drinks*

Product[1]	Processing days each week	Volume processed each day	Processing vats or blending tanks		Pasteurized storage vats or tanks	
			Size	Vat or tank loads prepared	Size	Vats or tanks utilized
	Number	*Gal*	*Gal*	*Number*	*Gal*	*Number*
Buttermilk	2	458	600	1	600	1
Ice cream mix	6	448	600	1	600	1
Soft serve mix	6	1,223	[2]600	2	1,000	[3]1
Fruit drinks	1	1,534	1,300	2	1,000	2
Skim milk	2	918	1,300	1	1,000	1
Chocolate milk	5	862	1,300	1	1,000	1
Half and half	2	233	1,300	1	1,000	1
Cheese dressing	2	295	1,300	1	1,000	1

[1] 1st 3 products processed by batch method; others blended in 1,300-gal tanks and processed by high temperature, short time method.

[2] 600-gal processing vat normally can handle an additional 50 gal.

[3] Excess volume over 1,000 gal is stored in one of the three 600-gal compartments of multicompartment tank.

ticompartment tank. The multicompartment tank that has three 1,300-gallon compartments provides the capacity needed for storing raw cream and blending the products processed by the high temperature, short time method. With the exception of fruit drinks, which require two compartments, each of the 1,300-gallon compartments has sufficient capacity for blending the total daily volume of each product processed. However, because of the total number of different products processed and only two compartments available for blending them, one compartment is needed for blending two products each day, 3 days a week. The three remaining of the four 1,000-gallon compartments of the multicompartment tank are adequate for storing pasteurized products. However, one compartment is used twice on the day that fruit drinks are processed.

Filling, Casing, and Stacking

Because of space restrictions in the filling area, some of the equipment is in the processing area, the cooler, and the case storage room. This separation has not seriously affected operating efficiency because additional conveyors and other equipment have been installed to compensate for the undesirable arrangement.

The products filled by the 75-unit-per-minute quart series and the 33-unit-per-minute ½-gallon fillers are cased separately using one caser for each filler. The cased products are automatically separated into groups of five cases and conveyed into the cooler for stacking using one of the two stackers. The products from the 10-unit-per-minute 1-gallon filler are manually cased and stacked by the same stacker used for the 75- and 33-unit-per-minute fillers. This arrangement places a heavier load on one of the stackers and presents a problem in keeping the cased products from each filler separated for stacking. The products from the 30-unit-per-minute plastic container and bag and box fillers are manually cased with the cases of filled plastic containers being stacked by the other stacker in the cooler. This stacker is inefficiently utilized because of the small volume of products filled by the plastic container filler. Since the stacker is not designed to handle the 24 quart cases used with the bag and box filler, these cases are passed through for manual stacking in the cooler. Their manual stacking is not a serious problem because of the small number. By having the stackers in the cooler rather than in the filling area, minor operational problems occur that cannot be avoided because of space restrictions.

The filling equipment can efficiently handle the present volume, even though the filling time for the large number of quart series containers (9 hours and 21 minutes) is much greater than for the 1-gallon or ½-gallon fillers (table 5). At the present volume, the operating of the 75-unit-per-minute filler plus the additional labor required because of the length of the filling time cost less than installing and operating a second or larger filler. Except for the ½-gallon plastic container filler, the major filling equipment is well utilized. The filling rate per hour at 80-percent efficiency with the present fillers is 1,522 gallons (table 3). The average filling time each day, excluding the 1,007 gallons packaged in dispenser boxes and bulk cans, is 7 hours and 43 minutes. The 1-hour-and-38-minute difference between the processing and filling times presents no problem since adequate storage is available.

Handling Cases and Cans

The case storage room and the adjoining rooms used for washing cans and housing the boiler feed water and water softening equipment are adequate to handle the present volume. Approximately 1,450 of the 1,758 square feet of floorspace in the case storage room are available for handling and storing empty cases. The rest is used to operate the bag and box filler and to store the wire baskets used in the ice cream processing operation. Based on the maximum daily volume of products processed and stored in 3,352 milk cases, only 1,192 of the 1,450 square feet of available floorspace are required for storing these cases in stacks 5 high, including space for aisles and equipment. The remaining space is available for storing surplus cases and miscellaneous supplies.

An above-floor power conveyor is used for unloading empty cases one at a time from the route trucks and moving them into the case room. Since the floor of this room is at ground level and a large proportion of the empty cases must be removed from the conveyor and placed in storage prior to use, excessive labor is required. Unloading empty cases one at a time with an above-floor conveyor results in poor labor utilization.

Cooler Storing and Shipping

The inventory schedule (table 2) shows that the maximum finished product holdover for processing, handling, and distributing the present volume of fluid milk products and fruit drinks is 16,561 gallons. Since 3,400 gallons are

TABLE 5.—*Filling equipment and total time required to fill present daily volume by type and size of container*

Type and size of container	Units	Gallons	Type of filling equipment	Time							
				Filling [1]		Change-over		Setup and cleanup		Total	
	Number	*Number*		*Hr*	*Min*	*Hr*	*Min*	*Hr*	*Min*	*Hr*	*Min*
Paper:											
1 gal	3,280	3,280	1 gal 10 u/m [2]	6	50	--	--	2	0	8	50
½ gal	11,180	5,590	½ gal 33 u/m	7	4	--	--	2	0	9	4
Plastic, ½ gal	614	307	½ gal 30 u/m	--	26	--	--	1	0	1	26
Paper:											
1 qt	1,868	467	Qt ser. 75 u/m	9	21	--	15	2	0	11	36
½ qt	3,060	255									
1 pt	608	76									
½ pt	28,112	1,757									
Dispenser box, 6 gal	132	792	Bag and box	1	50	--	--	--	15	2	5
Bulk can, 5 and 10 gal	39	215	Manual	--	39	--	--	--	--	--	39
Total	48,893	12,739		26	10	--	15	7	15	33	40

[1] At 80-percent efficiency.
[2] Units per minute.

transferred daily to the distribution facilities, the finished product holdover stored in the cooler is 13,161 gallons. To store this volume along with the cottage cheese and miscellaneous products requires about 1,958 of the 2,979 square feet of floorspace in the existing cooler.

Route orders are made up when the trucks arrive at the dock for loading. This procedure requires additional labor because of the time needed to assemble orders all at the same time for a large number of trucks waiting to be loaded.

The cooler dock is of proper height to accommodate semitrailers, but it is too high for loading the larger number of conventional route trucks. Because of the dock height and the restricted number of loadout points, excessive time and labor are incurred in loading trucks.

Receiving Supplies (Dry and Container Storage)

The storage areas for supplies are on the first and second floors of the processing plant and on different floors in the other buildings. Only a small amount of the total storage space requirements is provided in the plant and much of it is on the second floor. Most of the supplies are stored in separate buildings far removed from where they are needed. This separation along with the multistory buildings and the lack of docks significantly increases the cost of handling supplies.

Cottage Cheese Processing and Packaging

The cottage cheese processing room has sufficient space and contains the necessary equipment to handle the present volume. However, its location at the opposite corner of the plant from the cooler increases the cost of moving finished products to storage. The skim milk used in processing cheese flows from the high temperature, short time processor directly into the cheese vats, whereas the cheese dressing is stored in the processing and filling room and transferred on demand. The two 1,200-gallon cheese vats for processing the present daily volume are well utilized. However, the 30-unit-per-minute cheese cup filler and other equipment can handle a much greater volume.

Ice Cream Processing and Packaging

The ice cream processing room and adjoining rooms used for storage have sufficient space and contain the necessary equipment to handle the present volume. The mix is processed and stored in the processing and filling room and transferred as needed to the ice cream processing room for freezing. These operations are performed in widely separated rooms, which are inconvenient and require additional equipment and labor to conduct the operation.

Freezer Storing and Shipping

The freezer contains approximately 890 square feet of floorspace and is equipped with shelves that permit floor-to-ceiling stacking of finished products in wire baskets. The total capacity of the freezer is about 10,000 gallons. This provides sufficient storage space for a 10-day production inventory supply, as well as the 7,000-pound inventory of frozen novelties purchased from outside sources. Conveyors move products from the ice cream processing room to storage and to the trucks for loading. Trucks with reach-in type refrigerated bodies deliver frozen products to the local sales outlets as well as the distribution facilities. Transferring large volumes of products in these trucks to a single outlet or distribution facilities requires excessive labor.

Other Operations

The remaining plant areas and operations include, among others, the refrigeration and boiler rooms, the can storage room, and the administrative offices on the second floor. They are adequate to meet present needs and to handle future growth.

Deficiencies in Existing Facilities

The major problems with the present facilities and operations that cause increased operating cost are as follows:

- The separation of the receiving shelter from the processing plant is inconvenient and restricts the cross-utilization of labor between these operations.

- The lack of a dock adjoining the case storage room requires using an above-floor power conveyor to unload and handle empty cases one at a time.
- The supplies are stored on different floors in several buildings and generally are far removed from where they are used.
- Route orders made up in the cooler when the trucks arrive at the dock require more labor and time than if they were completed before the trucks arrive.
- The height of the cooler dock is impractical for loading the large number of conventional route trucks, and the dock has a restricted number of loading points.
- The mix processing and storing operation, which is widely separated from the ice cream processing room, is inconvenient and requires additional equipment and labor.
- The location of the cheese processing operation at the opposite corner of the plant from the cooler requires moving finished products a greater distance to storage.

ALTERNATIVES FOR SATISFYING FACILITY REQUIREMENTS

Because of deficiencies in the existing facilities and a 10-percent average annual production growth rate, changes are needed to satisfy facility requirements. Two alternatives are considered: (1) The existing facilities are remodeled until the volume of production exceeds the maximum capacity of the plant and (2) plans are developed for constructing new facilities to accommodate long-range growth.[3]

Based on the average annual growth rate, the present volume will increase by at least 50 percent within the next 5 years. The future volume of products processed and handled daily, based on a 5-day week, is 22,393 gallons. This volume includes 18,648 gallons of fluid milk products, 460 gallons of fruit drinks, and 3,285 gallons of skim milk and cream used in processing ice cream and cottage cheese (table 6). No change is expected in the present product mix shown in table 1. However, the volume of fluid milk products and fruit drinks in various types and sizes of containers is changed to meet expected consumer demands. The volume of ice cream, cottage cheese, and those products received from outside sources for distribution is increased uniformly by at least 50 percent. The filling of small ice cream containers from 5-ounce cups through quarts is eliminated to increase efficiency. These items are purchased from outside sources and maintained in inventory along with the processed products.

Of the total daily volume of 22,393 gallons, 19,111 are processed by the high temperature, short time (HTST) method and 3,282 by the batch method. The type and volume of each product group by method are as follows:

High Temperature, Short Time Method

Product group	*Gal*
Fluid milk	16,173
Fruit drinks	460
Skim milk for cottage cheese	2,301
Cheese dressing	177
Total	19,111

Batch Method

Buttermilk	275
Soft serve mix	2,200
Ice cream mix	807
Total	3,282

The suggested schedules (table 6–9) are used to determine the facility space and equipment requirements for processing and handling the future volume in both the remodeled and new facilities. The schedules are planned to meet the same criteria as those used to determine the adequacy of the existing facilities for handling the present volume.

[3] Prior to the construction of any remodeled or new facilities, all government agencies with regulations affecting the operation of dairy processing plants must be consulted in order to comply with specific requirements.

TABLE 6.—*Suggested daily schedule for processing, handling, and distributing future volume of fluid milk products and fruit drinks*

Item	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	Gal	*Gal*	*Gal*	*Gal*	*Gal*	*Gal*	*Gal*
Raw milk inventory	14,622	7,311	0	16,449	10,966	5,483	14,622
Raw milk receipts	14,622	14,622	16,449	16,450	16,450	16,450	14,622
Processed milk products	18,648	18,648	0	18,648	18,648	18,648	0
Milk for manufacturing purposes	3,285	3,285	0	3,285	3,285	3,285	0
Raw milk holdover	7,311	0	16,449	10,966	5,483	0	14,622
Processed fruit drinks	460	460	0	460	460	460	0
Sales - distribution:							
Milk products	17,715	17,715	9,324	14,919	17,715	15,852	0
Fruit drinks	438	438	231	367	438	388	0
Finished product holdover	23,885	24,840	15,285	19,107	20,062	22,930	22,930

TABLE 7.—*Suggested hourly schedule for processing and filling future volume of products based on high temperature, short time processing rate*

Schedule (hours)	Processing rate per hour [1]	Filling rate per hour [2]	Pasteurized product hold
	Gal	*Gal*	*Gal*
1st	2,095	1,874	221
2d	2,095	1,874	442
3d	2,095	1,874	663
4th	2,095	1,874	884
5th	2,095	1,874	1,105
6th	2,095	1,874	1,326
7th	2,095	1,874	1,547
8th	2,095	1,874	1,768
9th	2,095	1,874	[3] 1,989
10th (7 min)	253	[4] 733	[5] 1,509
Total	19,108	17,599	----

[1] At 90-percent efficiency.
[2] At 80-percent efficiency.
[3] Maximum volume of pasteurized product hold.
[4] 10th-hour filling schedule (23 min).
[5] Volume filled in dispenser boxes and bulk cans.

TABLE 8.—*Size and number of vats or tanks required for processing and storing future volume of fluid milk products and fruit drinks*

Product[1]	Processing days each week	Volume processed each day	Processing vats or blending tanks		Pasteurized storage vats or tanks	
			Size	Vat or tank loads prepared	Size	Vats or tanks utilized
	Number	*Gal*	*Gal*	*Number*	*Gal*	*Number*
Buttermilk	3	459	600	1	600	1
Ice cream mix	6	673	1,000	1	600	2
Soft serve mix	6	1,834	1,000	2	1,000	2
Fruit drinks	3	767	1,300	1	1,000	1
Skim milk	3	919	1,300	1	1,000	1
Chocolate milk	5	1,293	1,300	1	1,000	2
Half and half	2	350	1,300	1	1,000	1
Cheese dressing	2	445	1,300	1	[2] 600	1

[1] 1st 3 products processed by batch method; others blended in 1,300-gal tanks and processed by high temperature, short time method.

[2] Tank transferred to cheese processing room.

TABLE 9.—*Filling equipment and total time required to fill future daily volume by type and size of container*

Type and size of container	Units	Gallons	Type of filling equipment	Time							
				Filling[1]		Changeover		Setup and clean-up		Total	
	Number	*Number*		*Hr*	*Min*	*Hr*	*Min*	*Hr*	*Min*	*Hr*	*Min*
Paper, 1 gal	4,260	4,260	1 gal 10 u/m	8	52	--	--	2	0	10	52
Plastic:											
1 gal	660	660	1 gal and ½ gal 28–40 u/m.	2	24	--	15	1	30	4	9
½ gal	3,666	1,833									
Paper:											
½ gal	14,024	7,012	½ gal 33 u/m	8	51	--	--	2	0	10	51
1 qt	2,804	701	Qt ser. 75 u/m and qt ser. 45 u/m.	8	52	--	--	2	0	10	52
⅓ qt	4,596	383									
1 pt	912	114		8	34	--	15	2	0	10	49
½ pt	42,176	2,636									
Dispenser box, 6 gal	198	1,188	Bag and box	2	45	--	--	--	15	3	0
Bulk can, 5 and 10 gal	59	321	Manual	--	59	--	--	--	--	--	59
Total	73,355	19,108		41	17	--	30	9	45	51	32

[1] At 80-percent efficiency.

DESCRIPTION AND EVALUATION OF REMODELED FACILITIES

Although maximum operating efficiency cannot be achieved, the existing facilities are remodeled so that they can process and handle the future volume. Emphasis is on improving plant operations while avoiding major structural changes. Changes affecting the modification of the present equipment or the purchase of new equipment are based on immediate needs and their application for use in new facilities. Figure 3 shows the layout and equipment arrangement in the remodeled plant. Only those plant areas and operations that require change

nd can be economically justified are discussed ere.

Plant Operations Requiring Change

rocessing

A part of the container storage room, which ıcludes the small office, is converted into a rocessing area and used for installing both the 600- and 1,000-gallon multicompartment storage tanks. These tanks are relocated to make space available in the filling area for installing an additional filler.

The two 4,000-gallon standardizing tanks can handle the future daily volume of 10,955 gallons of homogenized milk, although three tanks have to be prepared each day. The high temperature, short time unit at 2,095 gallons per hour at 90-

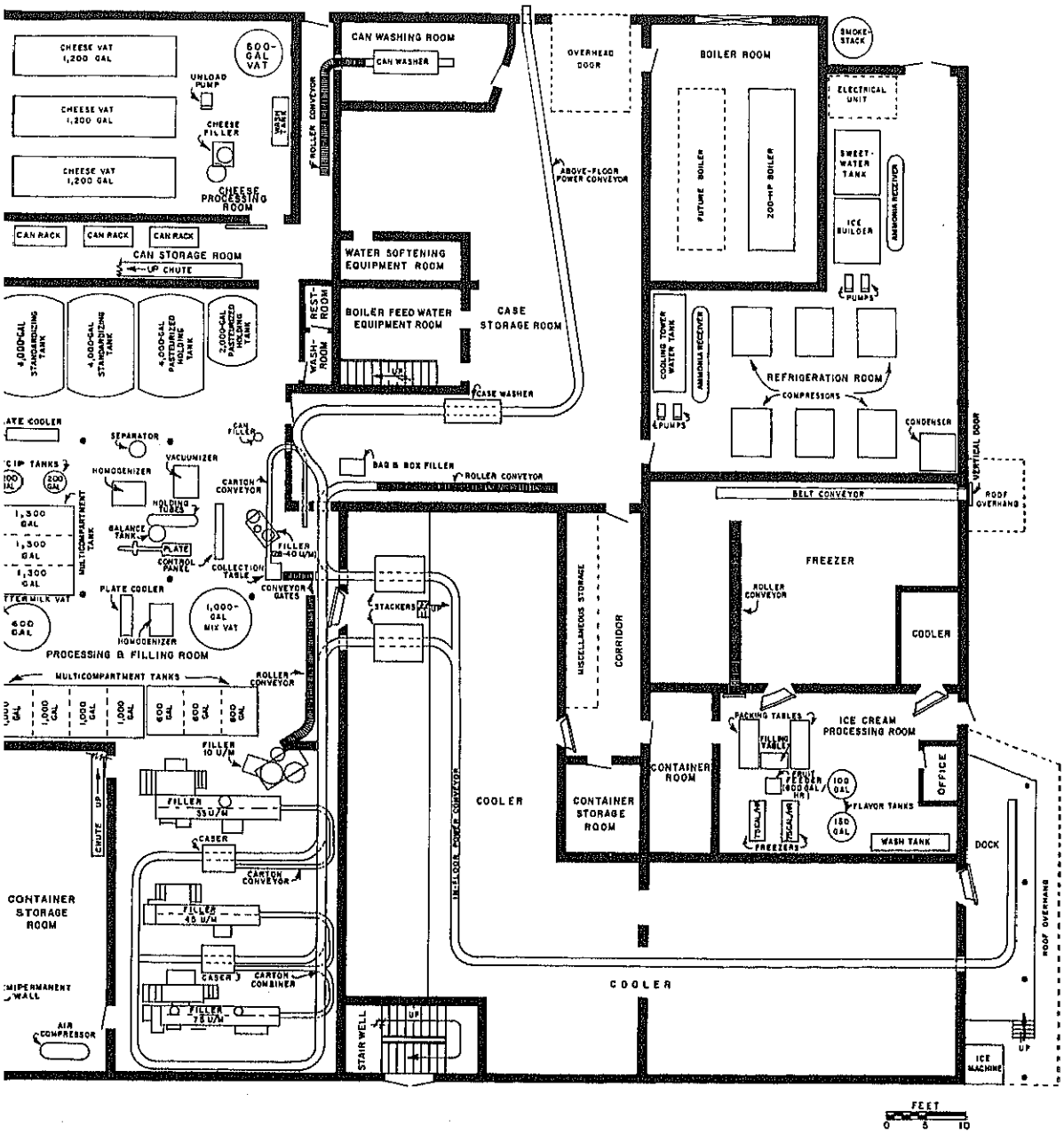


FIGURE 3.—Layout of remodeled plant.

percent efficiency can handle the future volume processed by this method in 9 hours and 7 minutes. The schedule for processing and filling in table 7 allows both operations to begin simultaneously and limits the pasteurized product hold to a maximum of 1,989 gallons. The 2,000- and 4,000-gallon pasteurized holding tanks can handle this volume and provide separate storage for the homogenized and the 2-percent skim milk.

The 600-gallon mix processing vat, which is replaced by a 1,000-gallon vat, is transferred to the cheese processing room for storing cheese dressing. The time needed to prepare the daily volume of mixes using the 600-gallon vat would exceed a one-shift operation and unnecessarily increase labor requirements. By changing the number of processing days each week, the 600-gallon buttermilk vat, the 1,000-gallon mix vat, and the three separate multicompartment blending and storage tanks are adequate to handle the future volume (table 8).

The total volume of ice cream and soft serve mixes (2,507 gal) processed each day, 6 days a week, requires three vat preparations using the 1,000-gallon vat. The multicompartment tank with three 600-gallon compartments is used for storing the daily volume of pasteurized ice cream mix and 40-percent cream, and one of the four 1,000-gallon compartments of the multicompartment tank is used twice a day for storing the soft serve mix.

The three-compartment 1,300-gallon-each multicompartment tank is used for storing raw cream and blending the total daily volume of each product processed by the high temperature, short time method. However, because of the total number of different products processed daily and only two compartments available for blending them, one compartment is used twice each day for blending two different products. With the exception of chocolate milk, which requires two compartments, each of the remaining three compartments of the 1,000-gallon multicompartment tank is used for storing the total daily volume of each product processed. Because of the total number of different products processed daily and only three compartments available for storing them, one compartment is used twice each day for storing two different products.

Filling, Casing, and Stacking

The filling equipment is rearranged to allow for the installation of a 45-unit-per-minute quart series filler to be used with the present 75-unit-per-minute filler. At the future volume level, the cost of operating these fillers plus the additional labor required because of the length of the filling time are approximately the same as using two 75-unit-per-minute fillers. Because of the uncertainty as to the future volume to be filled in ½-pint containers, the decision to install a larger capacity filler than the 45-unit-per-minute machine is delayed until the future volume is reached.

A carton combiner is used with one of the casers for casing those products filled by the quart series fillers. The other caser is for those products filled by the 33-unit-per-minute ½-gallon filler. An above-floor gravity roller conveyor is approximately 16 feet long with a curved section. It moves the cases of finished products, which are manually cased, from the 10-unit-per-minute gallon paper filler to the section of the above-floor power conveyor that extends to the stacker in the cooler. The filled cases are manually transferred from the roller conveyor onto the power conveyor for stacking.

The new arrangement allows one of the two stackers to be used for stacking cases of products filled by the quart series and ½-gallon paper container fillers. The other stacks the products filled by the 10-unit-per-minute paper container filler and the plastic container filler. Since the stacker is not designed to handle the 24-quart cases used with the bag and box filler, the cases are allowed to pass through for manual stacking in the cooler.

The 30-unit-per-minute plastic container filler is modified so that it can fill 1-gallon containers at 28 units per minute and ½-gallon containers at 40 units per minute. A 4-foot portable section of roller conveyor, which serves as a gate, extends from the collection table of the plastic container filler to the power conveyor for manual casing and controlling the flow of cased products. The flow of cases must

be controlled since the same section of power conveyor moves products from three separate fillers to the stacker in the cooler.

The filling equipment is adequate to efficiently handle the future volume. Except for the 1- and ½-gallon plastic container filler, the total filling time for each machine is approximately the same, averaging about 10 hours and 51 minutes a day (table 9). By having the filling times balanced, the filling, casing, and stacking operations are started and completed at about the same time to minimize the labor requirements in the case storage room and cooler. As shown in table 7, the filling rate per hour at 80-percent efficiency is 1,874 gallons. The average daily filling time, excluding the 1,509 gallons packaged in dispenser boxes and bulk cans, is 9 hours and 23 minutes. With a processing time of 9 hours and 7 minutes, a satisfactory balance is established between processing and filling.

Handling Cases and Cans

Approximately 5,028 empty cases are needed to store the maximum daily volume of processed products. The case storage room, which contains 1,450 square feet of available floorspace, is adequate for storing these cases in stacks six high, including space for aisles and equipment. This storage method utilizes 1,425 of the 1,450 square feet of available floorspace and presents only minor operational problems where cases are manually handled.

Cooler Storing and Shipping

The inventory schedule (table 6) shows that the maximum finished product holdover for processing, handling, and distributing the future volume of fluid milk products and fruit drinks is 24,840 gallons. By transferring 5,100 gallons to the distribution facilities, the finished product holdover stored in the cooler is 19,740 gallons. To store this volume along with the cottage cheese and miscellaneous products requires about 2,935 of the 2,979 square feet of cooler floorspace. The cooler is adequate for storing and handling the future volume; however, because of the two floor levels some problems occur in efficiently utilizing the existing floorspace.

The cooler operations are changed in order to increase efficiency and expedite the loading of trucks. Route orders are made up in the cooler in advance and stored in a predetermined sequence for loading. This method of operation avoids the problem of having to assemble the orders all at the same time for a large number of trucks waiting to be loaded. Route trucks are scheduled for loading during those hours when products are processed and filled. Incoming receipts are also scheduled during the same period. By performing these functions as products are processed and filled, the labor requirements in the cooler are better utilized.

Cottage Cheese Processing and Packaging

The cheese processing room is expanded to a width of 24 feet by including a part of the can storage area. Space is provided for housing the present equipment, the 600-gallon vat used for storing cheese dressing, and a third 1,200-gallon cheese vat. Approximately 5,750 pounds of creamed cottage cheese are processed each day, 4 days a week. The three 1,200-gallon vats can handle the daily volume of approximately 24,850 pounds of skim milk used in processing cheese. The 600-gallon vat has sufficient capacity to store the 445 gallons of cheese dressing processed each day, 2 days a week (table 8).

Ice Cream Processing and Packaging

The ice cream processing operation is changed from a 6- to a 5-day week to obtain better utilization of the labor and equipment. The packaging of 5-ounce cups through quart containers of ice cream is discontinued, with larger containers being filled with that volume of product. The manual filling of small containers is time consuming and requires a substantial amount of labor in relation to the volume packaged. Since only 20 percent or 323 gallons of the total daily volume processed (1,614 gallons) is packaged in these containers, to invest in an automatic filler is not economically feasible. By purchasing those products packaged in small containers from outside sources and by improved scheduling of labor assign-

ments, the labor requirements in the ice cream processing operation are better utilized.

Freezer Storing and Shipping

The existing freezer and operating methods are adequate to handle the future volume provided the maximum inventory supply is reduced from 10 to 5 days of production. By making this change, space is available for storing the total volume of processed products (8,070 gal) as well as the increased volume of frozen novelties (10,500 lb) and the small containers of ice cream products purchased from outside sources.

Limitations of Remodeled Facilities

The remodeled facilities are adequate for processing and handling only up to a 50-percent increase in present volume because of restrictions at the present site. Also, operational inefficiencies exist that cannot be corrected without making major changes involving an unrealistic cost. Most of the deficiencies in the existing facilities are still prevalent in the remodeled plant. To overcome these limitations, plans are developed for the construction of new facilities.

DESCRIPTION AND EVALUATION OF NEW FACILITIES

The new facilities are designed and equipped to efficiently process and handle a 50-percent increase in present volume, with provisions for further expansion to accommodate long-range growth. The building site includes the processing plant, a separate warehouse and garage, an enclosed truck washing unit, and other supporting installations.

Overall Design

The processing plant contains approximately 30,750 square feet of floorspace and is essentially a one-story structure, with processing operations on the first floor and administrative offices at the front of the building on the second floor (fig. 4). It is constructed of reinforced concrete and steel, with the front finished in brick to provide an attractive exterior (fig. 5). A 23-foot ceiling height is planned throughout the plant, except the 12-foot height of that part of the cooler that extends beyond the main body of the plant. The administrative offices have a 10-foot ceiling height. The space beneath, including most of the case storage room, all the auxiliary areas, and a part of the dry and container storage room, has a 12-foot ceiling height. The receiving shelter and the boiler and refrigeration rooms are at ground level, with a ceiling height of approximately 27 feet.

The administrative offices extend 13 feet beyond the first floor at the front of the plant and are supported by columns from ground level. They include the various areas needed to conduct the plant operations but can be rearranged as desired to fit specific requirements. The interior arrangement (fig. 6) allows the processing and filling room to be observed from the conference room, office, and employee welfare and drivers room through large observation windows at the rear. This improves management control, permits visitors to observe the operations without having to enter the processing areas, and thus avoids affecting plant sanitation and endangering the safety of individuals.

The plant is designed with the processing and filling area near the center and the supporting areas adjacent to and extending to the outside perimeter. This arrangement allows each plant area to be easily expanded for future growth. A good flow pattern is provided with the individual areas and equipment arranged in sequence to simplify operations and minimize cost. Most of the equipment is transferred from the remodeled plant. The rest is purchased new to replace equipment that is either worn out or that cannot be removed.

A breakdown of usable floorspace by individual plant areas, excluding covered docks and wall areas, is as follows:

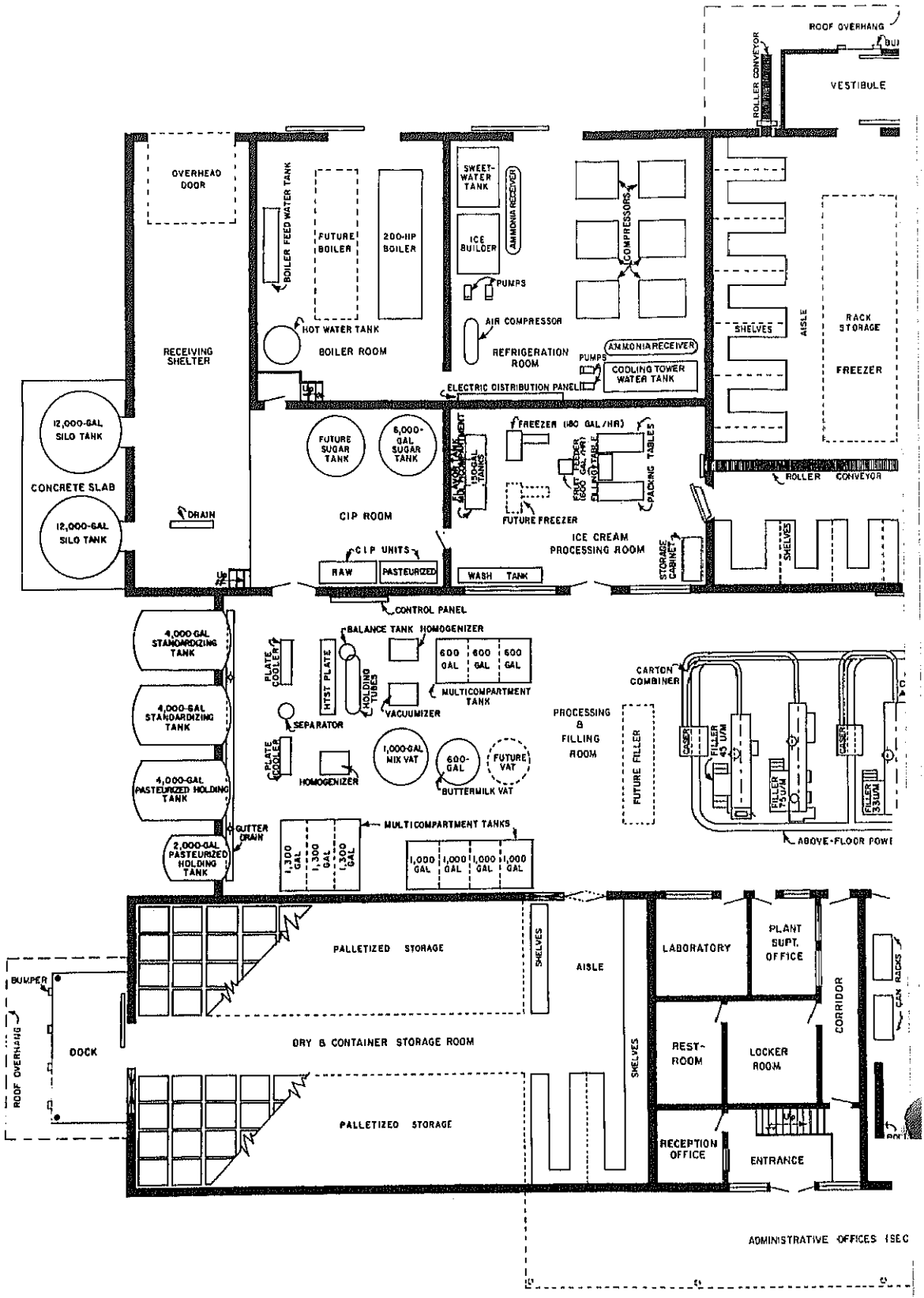


FIGURE 4.—Layout of

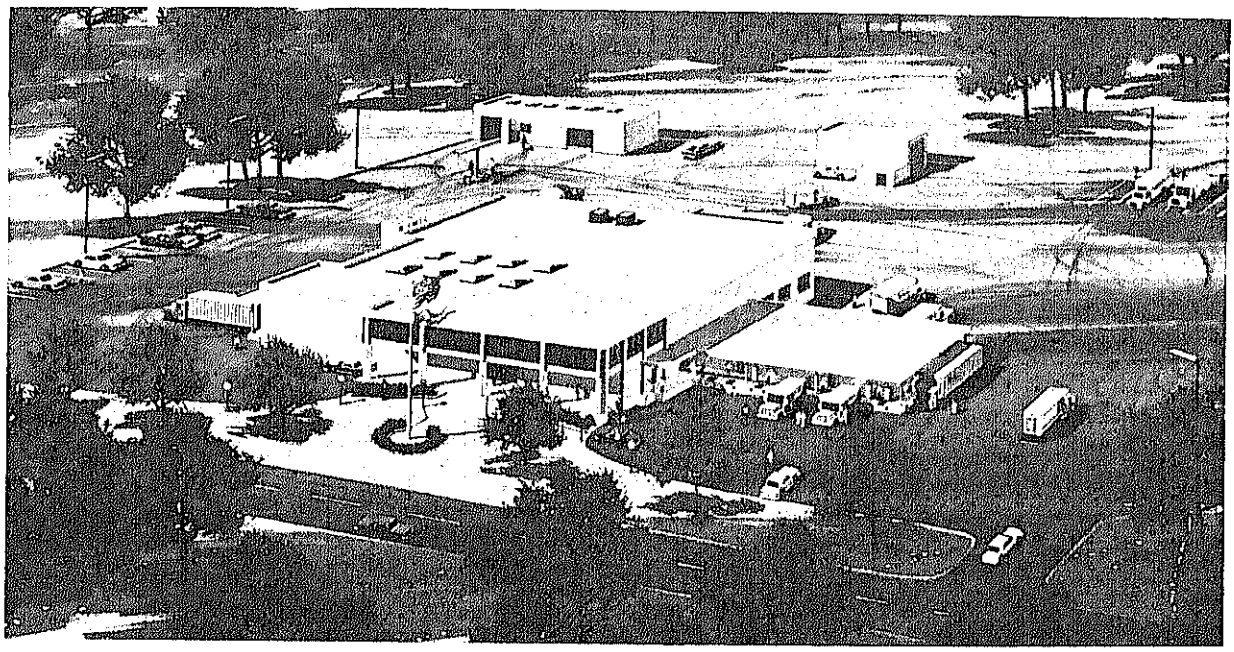


FIGURE 5.—Artist's conception of new plant.

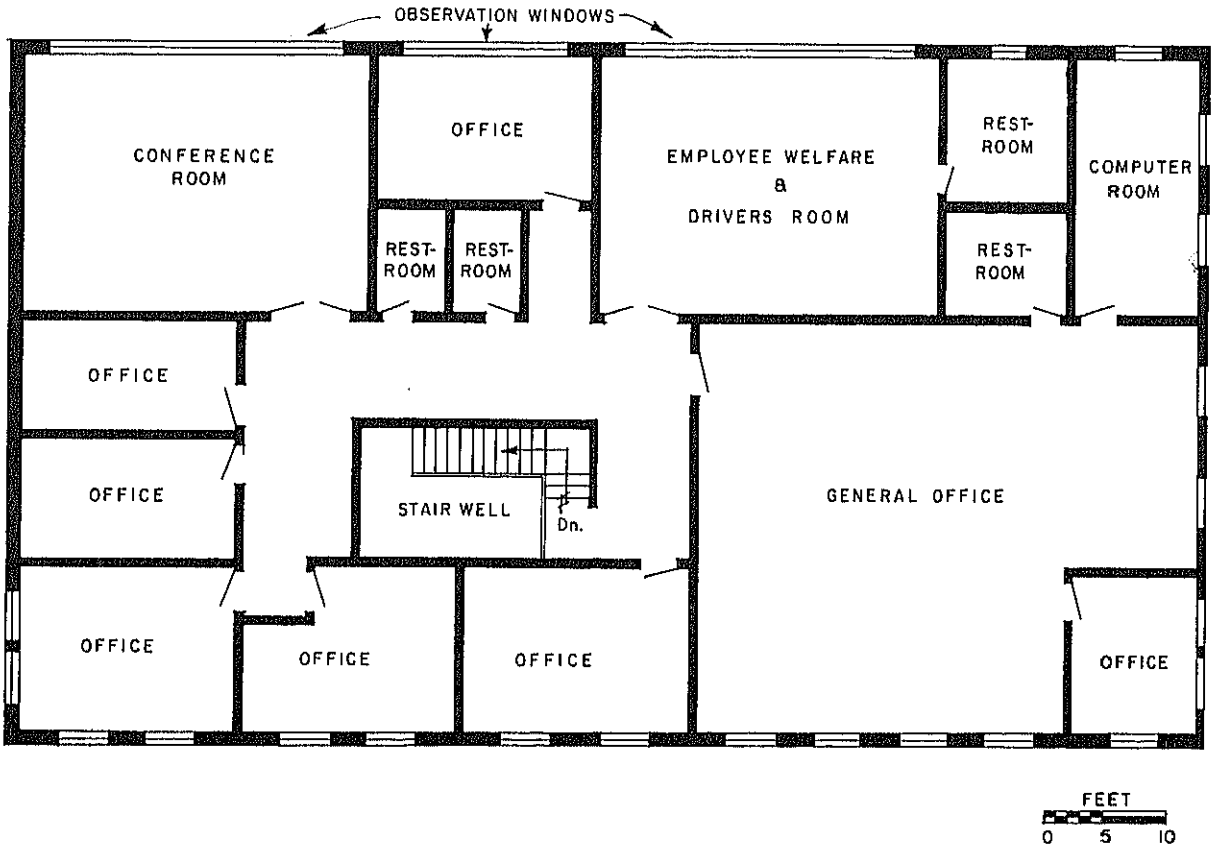


FIGURE 6.—Layout of administrative offices in new plant.

Plant area	*Ft²*
Receiving shelter	960
CIP (cleaned in place) room	648
Processing and filling room	4,680
Case storage room	2,094
Cooler	3,010
Dry and container storage room	2,698
Cheese processing room including vestibule	1,422
Ice cream processing room	840
Freezer including vestibule	2,600
Refrigeration room	1,225
Boiler room	910
Laboratory	156
Plant superintendent's office	117
Employee locker room and restroom	284
Entrance and reception office	400
Administrative offices (second floor)	4,554
Total	26,598

Space is provided for processing and handling not only fluid milk products and fruit drinks but also ice cream and cottage cheese. Should processing of either one or both of these last two products be discontinued, the space could be used for expansion or for processing new products. Their location next to the freezer and cooler would be ideal for processing and handling dairy-related products.

Many design characteristics must be incorporated in the construction of the plant. The floors must have smooth surfaces that are impervious to moisture and easily cleaned. They must be constructed with sufficient strength to support maximum equipment and vehicle weight. The type, size, and location of floor drains and the slope of the floor must be adequate for removing water that is normally discharged in a processing operation. The walls and ceilings must be smooth, washable, light in color, and moisture resistant. Hot and cold water outlets and hand-washing facilities must be provided and conveniently located in areas where they are needed. For additional details, refer to the regulations.[4]

Safety factors must be incorporated into the plant design for employee protection. Also, the construction materials selected must absorb sound in order to minimize the noise level and comply with the standards.[5] Adequate lighting, heating, air-conditioning, ventilation, and plumbing and electrical facilities must be provided throughout the plant. Provision must also be made to handle the effluent discharged from the plant. Good handling practices are essential; however, in some instances, waste-treatment facilities are needed to comply with the guidelines.[6] Qualified personnel should be consulted to determine these requirements.

A warehouse, 35 feet wide and 60 feet long, is provided for storing surplus equipment and supplies not used on a day-to-day basis in the plant. It is of masonry construction with a steel supported roof. The ceiling height is 20 feet to permit high stacking of supplies. The floor is approximately 50 inches above ground level for loading and unloading trucks. A doorway, 10 feet wide and 12 feet high, provides access to the warehouse. Vertical bumpers are installed on the face of the foundation to protect the vehicles and building. A dock plate is used to bridge the gap between the truckbed and warehouse floor.

A four-bay garage, 35 feet wide and 50 feet long, is included for servicing the route trucks and other vehicles assigned to the plant operation. Its ceiling height is 24 feet to correspond with the warehouse ceiling. The garage is also of masonry construction with a steel supported roof. Doorways, 12 feet wide and 16 feet high, provide access to the garage.

A truck washing unit is installed in a building 16 feet wide and 52 feet long with an adjoining control room. This building is of masonry construction with a steel supported roof and of sufficient height to house the particular unit. Space is available for washing both semitrailers and conventional route trucks. A doorway, 12 feet wide and 16 feet high, provides access at each end of the building. The unit provides a rapid, efficient method of wash-

[4] Grade "A" Pasteurized Milk Ordinance, 1965, Recommendations of the United States Public Health Service of the U.S. Department of Health, Education, and Welfare.

[5] Williams-Steiger Occupational Safety and Health Act of 1970. Occupational Safety and Health Administration of the U.S. Department of Labor, Effective April 28, 1971.

[6] Effluent Limitation Guidelines for the Environmental Protection Agency, Pre-Treatment Standards Applications for the Dairy Products Processing Industry, Point Source Category. Fed. Reg., v. 39, p. 18594.

ing trucks and aids in maintaining a clean, attractive fleet. In areas with milder climates, an enclosed structure is not essential.

Facilities Arrangement on the Site

The processing plant and supporting installations are on a 5½-acre site, 565 feet wide and 425 feet deep (fig. 7). The site is convenient to the area it serves, reasonably level, and well drained. It has an adequate supply of water, electricity, and sewage facilities. It is in a low density traffic area and accessible to the major transportation arteries.

Processing Plant.—The processing plant is near the center of the site, approximately 80 feet from the front property line. Space is provided on each side and at the rear for maneuvering vehicles and for future growth.

Warehouse and Garage.—The warehouse and garage are adjoining buildings at one corner to the rear of the site and approximately 160 feet from the processing plant. Space along the front of the buildings is for maneuvering vehicles and at one end for enlarging the warehouse.

Truck Washing Unit.—The building housing the truck washing unit is between the warehouse and truck parking area. Space between each end of the building and the expansion areas of the warehouse and truck parking area is for maneuvering trucks.

Gas Island.—A gas island is provided for servicing the route trucks and other vehicles assigned to the plant operation. It is about 60 feet from the property line and in front of the warehouse and garage but near enough to allow garage personnel to service the trucks.

Vehicle Parking.—Parking spaces are available for 40 cars and 16 route trucks. The car parking spaces, 10 feet wide and 20 feet long, are parallel to the property line at each side of the plant. They are used by plant personnel, visitors, and others. The truck parking spaces, 10 feet wide and 25 feet long, are to the rear at the opposite corner from the warehouse and garage. They supplement the parking spaces along the plant docks. Expansion space is provided next to the truck parking area for six additional vehicles. Electric outlets for the truck refrigeration units are along the rear of the parking area.

Driveways.—Two driveways, 40 feet wide on each side at the front of the site, provide access to the plant. The driveways and all other areas that are subject to vehicular traffic are hard surfaced with concrete, blacktop, or crushed stone of sufficient strength to support maximum vehicle weight and are sloped for proper drainage.

Landscaping.—To improve the appearance and attractiveness of the plant, the area along the front and at the corners of the site is landscaped. Emphasis is on making the administrative offices the focal point of the plant.

Plant Operations

Figure 4 shows the arrangement of the plant areas and the equipment needed to process and handle the future volume.

Receiving

The receiving shelter, 16 feet wide and 60 feet long, is a single-stall back-in-type facility. It is equipped with an electrically operated overhead door, 12 feet wide by 14 feet high. Space is provided to accommodate either tanker transport trailers or bulk farm pickup trucks. The single-stall shelter is adequate to handle the small number and type of trucks used in hauling the daily supply of raw milk to the plant.

The maximum volume of raw milk inventory is 16,449 gallons (table 6). The two 12,000-gallon silo tanks alongside the shelter are adequate to handle this volume. However, if additional raw milk storage capacity is required because of a variation in the pickup schedule, the two 4,000-gallon standardizing tanks in the processing operation could also be used for storage.

A CIP (cleaned in place) room, 24 feet wide by 27 feet long, is next to the receiving shelter. Space is provided for installing two CIP units, the 6,000-gallon liquid sugar tank, and a future sugar tank. One CIP unit is for cleaning the tank trucks, the raw milk storage tanks, and other equipment used in handling the raw product; the other unit is for cleaning the equipment used in handling pasteurized products.

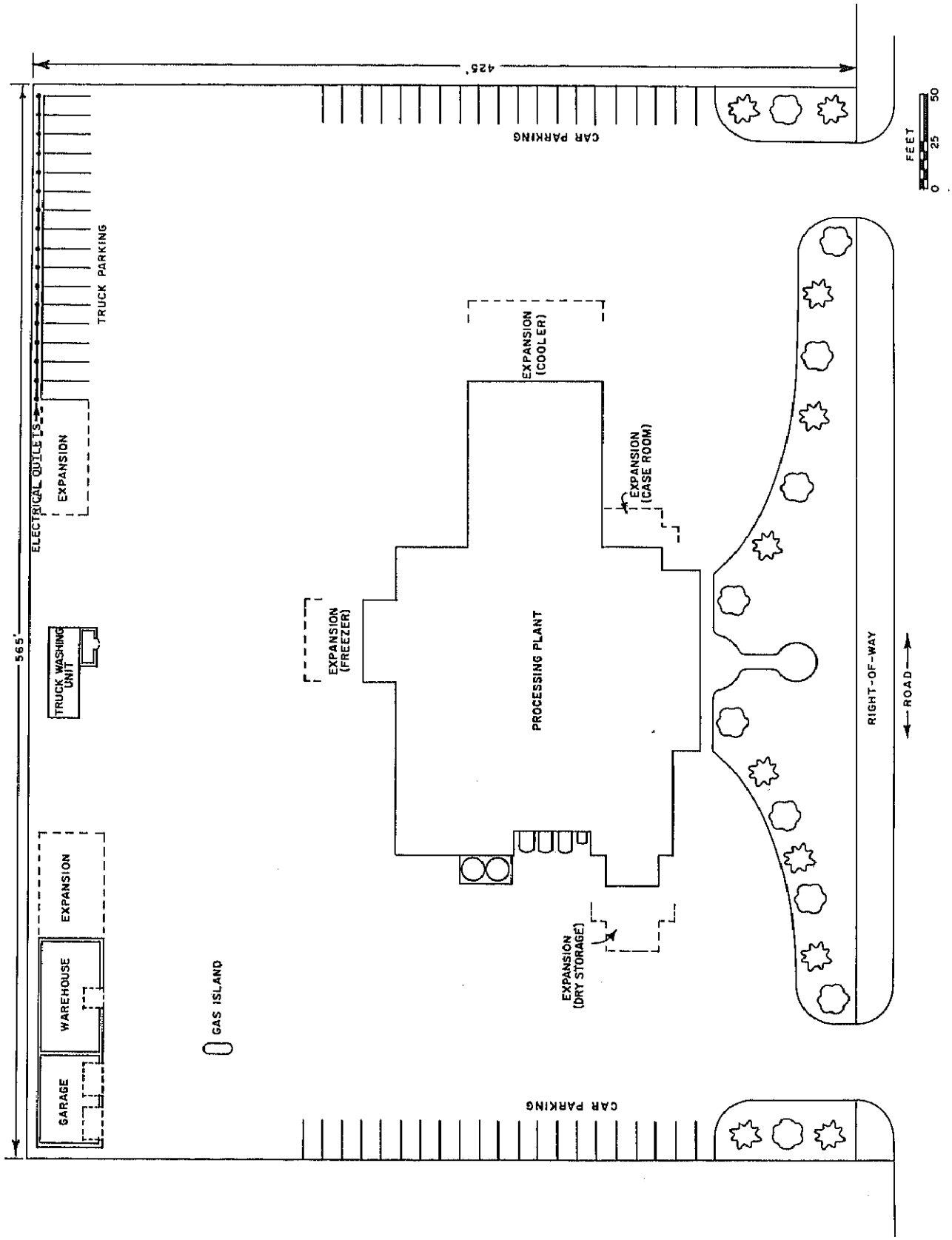


FIGURE 7.—Site plan for new facilities.

Processing

The processing and filling room is 40 feet wide and 117 feet long, with the processing operations at one end and the filling operations at the other. The processing operations are next to the receiving shelter and occupy approximately 42 percent of the total floorspace in the processing and filling room. Space is provided for installing new processing equipment, equipment transferred from the remodeled plant, and additional and larger equipment when needed. Space is also provided for working areas around the equipment, the movement of personnel, and the operation of materials-handling equipment.

The 2,000- and the three 4,000-gallon tanks are installed outside the plant with the tank heads protruding through the wall into the processing area. In this type of installation, the tanks do not occupy valuable floorspace in the processing area and their installation and removal are simplified.

Filling, Casing, and Stacking

The filling operations are at the opposite end from the processing operations and occupy the remaining 58 percent of the total floorspace. Space is provided for installing new filling equipment, equipment transferred from the remodeled plant, and additional and larger equipment when needed. Like the processing area, space is also provided for working areas around the equipment, the movement of personnel, and the operation of materials-handling equipment.

In the filling operation, one caser is used with a carton combiner for casing those products filled by the quart series fillers. The other caser is used for the products filled by the ½-gallon filler. By controlling the speed of the power conveyors and installing an automatic holding device, the filled cases can be separated for stacking. One of the two stackers stacks the cases of finished products filled by the quart series and ½-gallon fillers. The other stacks those products filled and manually cased from the remaining fillers. By installing a manually operated conveyor holding device where the two separate power conveyors converge into one prior to entering the stacker, the remaining fillers can be operated simultaneously. Since the stacker is not designed to handle 24-quart cases, the cases of products from the bag and box filler are passed through for manual stacking in the cooler. The manual filling of bulk cans is conducted in that area designated for a future filler. Portable racks are used to move the empty cans from the case storage room to the filling area and into the cooler.

A supply rack for bundles of preformed plastic containers is installed along and above the section of the above-floor power conveyor that carries empty cases to both the 10-unit-per-minute paper container filler and the 28- to 40-unit-per-minute plastic container filler. Individual containers are manually removed from the bundles and placed on the feed conveyor for filling. The rack provides temporary off-floor storage and simplifies the handling of plastic containers.

Handling Cases and Cans

The case storage room next to the filling area and cooler is 48 feet wide and 53 feet long at the longest point. Approximately 5,028 cases are needed for storing the maximum daily volume of processed products. Of the 2,094 square feet of floorspace in the case room, only 1,368 are required for storing these cases in stacks five high. The remaining space is for storing a reserve supply of cases, for installing and operating the equipment, and for aisles and working areas. The small area of the case room adjacent to the cooler is for storing and handling the 24-quart cases needed in the bag and box filling operation, whereas the rest of the room is for storing and handling the 16-quart cases and operating the can washing equipment. Approximately 330 square feet of floorspace are for storing a reserve supply of 1,200 empty cases. This reserve allows for daily fluctuation in production, yet minimizes the space requirements in the case room. The cooler dock is used in conjunction with the case room for storing and handling the normal turnover inventory of empty cases. A ratio of one case in use to three in reserve is not unusual in a plant operation.

Empty cases are transferred in stacks five high by the in-floor power conveyor from the

cooler dock into the case room. They are manually destacked and placed on the appropriate conveyor for moving into the filling area. Since the case room operator has sufficient time to destack empty cases as well as performing the remaining functions, an automatic destacker for the 16-quart cases cannot be economically justified at the future volume level. Portable racks are used to transport the empty cans from the cooler dock to the can washer and for storing them prior to filling.

Cooler Storing and Shipping

The cooler, 35 feet wide and 86 feet long, is next to the processing and filling room, the cheese processing room, and the case storage room. It extends 68 feet beyond the plant to provide space on each side and at the end for loading and unloading trucks. Space is included for aisles and conveyors and for storing the wholesale and retail route orders plus a reserve supply of products. The inventory schedule (table 6) shows that the maximum finished product holdover for processing, handling, and distributing the future volume is 24,840 gallons. Since 5,100 gallons are transferred daily to distribution facilities, the finished product holdover stored in the cooler is 19,740 gallons. To store this volume along with the cottage cheese and miscellaneous products requires approximately 2,935 of the 3,010 square feet of cooler floorspace.

Route orders are made up in the cooler in advance and stored in a predetermined sequence for loading. The wholesale route orders each require floorspace measuring 6 feet wide by 8 feet long and are stored on one side of the in-floor power conveyor two deep with 3-foot-wide aisles for assembling orders. The retail route orders each require floorspace measuring 4 feet wide by 6 feet long and are stored on the opposite side of the conveyor three deep with 3-foot-wide aisles for assembling orders. Space is provided for assembling and storing 12 wholesale and 24 retail route orders. The wholesale route orders are removed from the cooler by the truck drivers, whereas the retail orders are pulled onto the in-floor power conveyor by cooler personnel and moved to the dock for loading.

A dock extends along both sides and across the end of the cooler. The area on one side is for loading wholesale trucks and on the opposite side for loading retail trucks. The area at the end is for loading and unloading semitrailers. The dock is covered by a roof 12 feet high, the same height as the cooler. The roof extends 10 feet over the apron to protect the loading and unloading operations during inclement weather.

The dock area for loading wholesale trucks is 4 feet wide and 45 inches high—slightly higher than the average truckbed. Two methods can be used in loading wholesale route orders. One is the use of an in-floor power conveyor for moving the stacks of cases from the cooler to the dock. Since a conveyor normally moves the stacks of products faster than a truck can be loaded, an area at least 6 feet wide is needed between the conveyor and the dock edge so that the route orders can be removed and temporarily stored at the rear of the truck. This space prevents one truck from tying up the conveyor during the loading operation. By using this method, personnel are required to manually drag the stacks of cases onto the conveyor in the cooler, and the truck drivers are required to handle them again prior to loading.

The second and preferred method is to manually drag the stack of cases from the cooler directly into the trucks, using each of the three doors for loading two trucks simultaneously. The distance required for dragging the stacks of cases directly from the cooler is about the same as using a conveyor system. By using the preferred method, stacks of cases are handled only once, and the equipment and construction cost is held to a minimum.

The dock area for loading retail trucks is 8 feet wide and 36 inches high—slightly higher than the average truckbed. The in-floor power conveyor is 3 feet from the dock edge and 4 feet from the cooler wall. The 3-foot-wide area between the conveyor and dock edge is for temporarily storing the individual route orders that are removed from the conveyor. Since the conveyor normally moves the stacks of products faster than they can be loaded on a truck, the

use of this area allows the conveyor to continue moving and thus eliminates a tieup in the loading operation. The 4-foot-wide area between the conveyor and cooler wall is used as a passageway and for storing empty cases. Space is provided for storing approximately 640 empty cases in stacks 5 high.

The dock area at the end of the cooler is 19 feet wide by 49 feet long and 52 inches high to correspond to the average truckbed height of semitrailers. It is used for storing empty cases and for loading and unloading semitrailers. Space is provided for storing approximately 1,280 empty cases in stacks 5 high, for operating the in-floor power conveyor, and for aisles and working areas.

Stalls are provided on each side of the cooler along the dock for loading six wholesale and eight retail trucks. The two stalls near the end of the dock next to the wholesale truck loading area are for unloading empty cases from the wholesale trucks. Dock space at the end of the cooler is for loading and unloading one semitrailer by the side door or up to four by the rear doors.

Other considerations are complied with in the design and operations of the cooler and dock. Vertical bumpers are installed on the face of the dock to protect it and the vehicles during loading and unloading. Plate steel loading flaps hinged on steel rods are permanently attached to the dock and used to bridge the gap between it and the trucks. A gutter with drainage outlets encircles the entire cooler dock area. A guard rail on the apron serves as a guide for parking semitrailers alongside the dock. For additional information on the layout and operation of a cooler, refer to Marketing Research Report 990, "A Dairy Products Distribution Facility: Layout and Operating Methods," Agricultural Research Service, U.S. Department of Agriculture.

Receiving Supplies (Dry and Container Storage)

The dry and container storage room, 38 feet wide and 71 feet long, is at the front of the plant next to the processing and filling room. In that section of the room with a 23-foot ceiling height, 264 pallet loads of supplies can be stored on drive-in pallet racks stacked 4 deep and 3 high on each side of the center aisle (fig. 8). An inventory supply of approximately 350 four-way pallets, 42 by 48 inches, is needed for storing and handling supplies (fig. 9). The area beneath the administrative offices with a 12-foot ceiling height is used for shelf storage and for servicing the materials-handling equipment. The aisles are 8 feet wide to allow space to operate a pallet stacker or a narrow aisle forklift truck.

An electric walkie-type pallet stacker (fig. 10) with a minimum capacity of 3,000 pounds is needed to receive and store supplies and to transport them throughout the plant. Two- and four-wheel handtrucks are used to move small volumes of supplies to areas where it is not practical to use the stacker. Doorways, 6 feet wide and 8 feet high, permit the palletized movement of supplies. A section of semipermanent wall is installed on each side so that larger equipment can be moved in or out of the plant.

A covered receiving dock, 10 feet wide and 20 feet long, provides space for unloading two trucks simultaneously. The dock height is approximately 52 inches to correspond with the average truckbed height of semitrailers. Vertical bumpers are installed on the face of the dock to protect it from vehicle damage. Bridge plates are used to span the gap between the dock and trucks to compensate for variations in truckbed height. The roof is 16 feet above the apron and extends 6 feet beyond the edge of the dock. It is supported by columns on the outside corners of the dock and provides protection for unloading during inclement weather.

Cottage Cheese Processing and Packaging

The cottage cheese processing room, 27 feet wide and 50 feet long, is at the outside corner of the plant next to the freezer and cooler. Space is provided for installing and operating the equipment transferred from the remodeled plant and for larger capacity equipment if needed. A section of semipermanent wall is installed on the outside wall so that the equipment can be moved in or out of the room.

A vestibule, 8 feet wide and 9 feet long, pro-

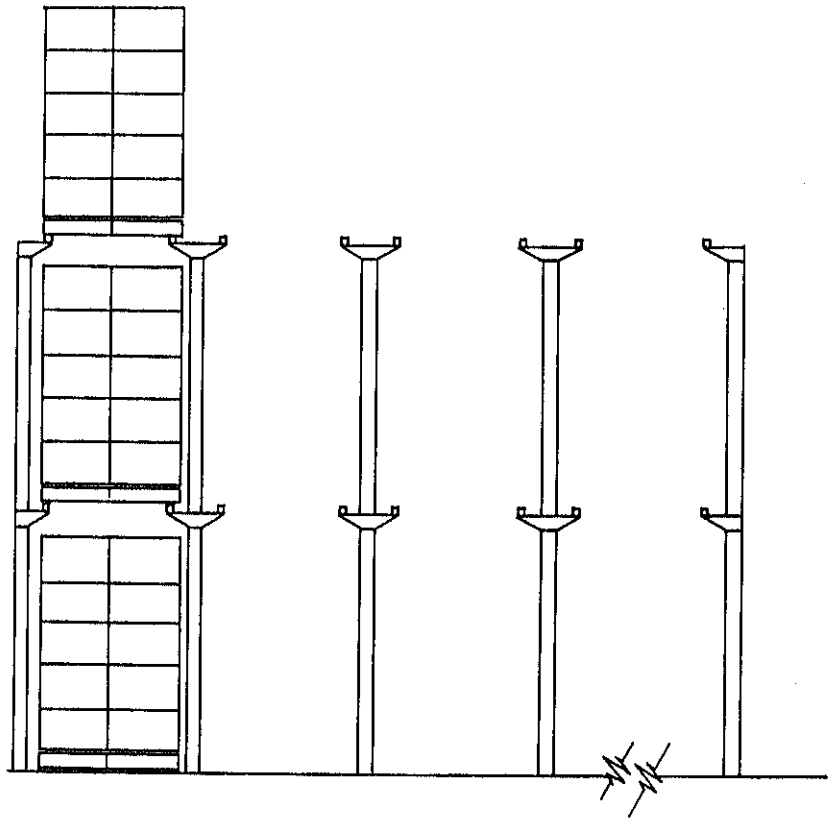


FIGURE 8.—Drive-in pallet racks.

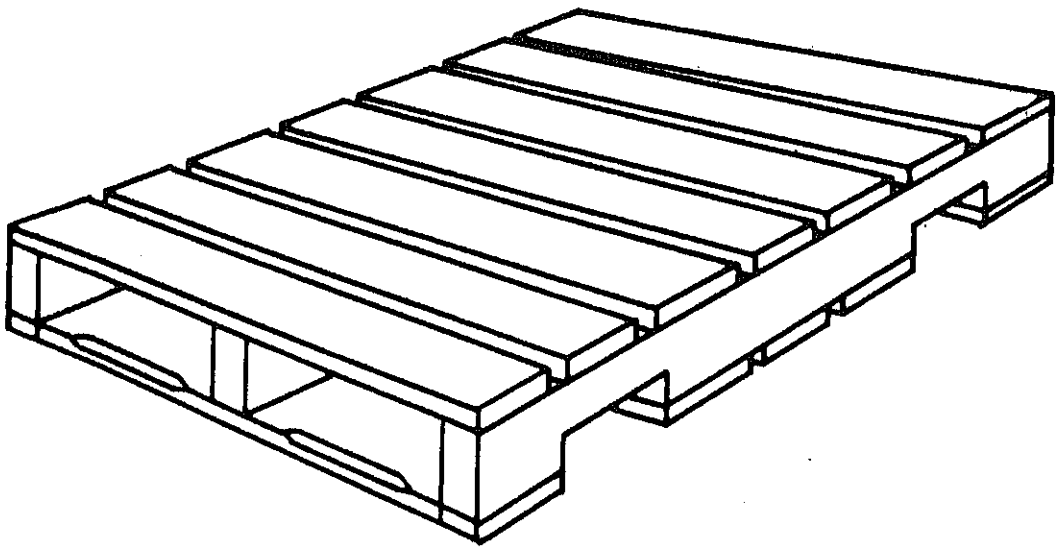


FIGURE 9.—Four-way pallet.

vides access from the processing and filling room into the cheese processing room. It helps control the environmental conditions in the room and aids in preventing bacterial contamination of the product, which can be a problem in processing cheese.

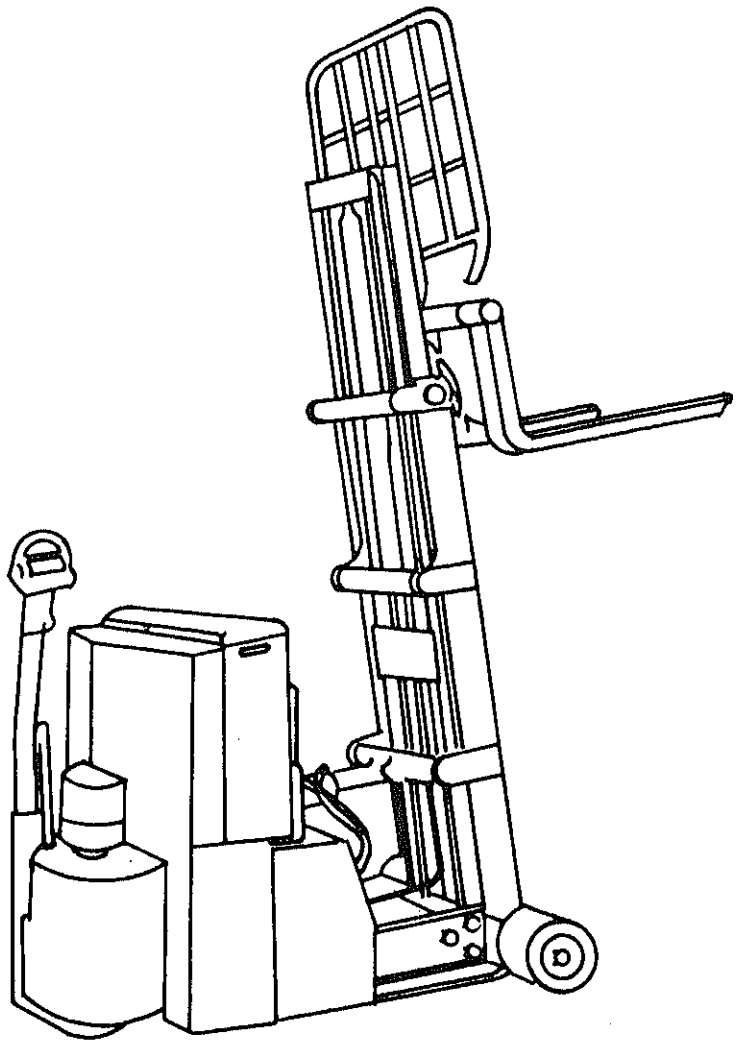


FIGURE 10.—Pallet stacker.

Packaging materials and empty cases are transferred from their respective locations to the cheese processing room either on pallets or handtrucks. The vestibule is used for storing these items until needed in the processing room. The finished products are manually cased and transferred on pallet dollies to the cooler in stacks five cases high. They are stored in the reserve supply area adjacent to the processing room and selected as needed in assembling route orders.

Ice Cream Processing and Packaging

The ice cream processing room, 24 feet wide and 35 feet long, is between the processing and filling room and the refrigeration room. This location reduces the installation cost of the equipment and minimizes refrigeration losses. Space is provided for housing and operating new equipment, equipment transferred from the remodeled plant, and the future installation of a second freezer and an automatic filler should they be needed.

The two separate 75-gallon-per-hour freezers are replaced by a single-barrel 180-gallon-per-hour freezer, which can handle a much greater volume simply by adding a second barrel. A three-compartment 150-gallon-each multicompartment flavor tank replaces the 100- and 150-gallon tanks. This equipment adds flexibility to

the operation and eliminates the possibility of a shutdown because of an insufficient flow of product. The equipment is replaced because of its age, condition, and inability to efficiently handle future growth.

Packaging materials are transferred from storage to the ice cream processing room either on pallets or by handtrucks depending on the type and volume used. The processing ingredients that are stored in the cooler and freezer are transferred manually. Products are manually packaged and placed on a 10-foot section of a gravity flow roller conveyor, which extends from the packing tables to the permanently installed conveyor in the freezer. This arrangement allows all packaged products to flow directly into the freezer for holding prior to storing on the shelves or racks. In some instances, filling the racks at the packing tables rather than in the freezer might be desirable; however, care must be taken that products do not remain too long at room temperature or their quality will be affected.

Freezer Storing and Shipping

The freezer, 40 feet wide and 60 feet long, is next to the ice cream processing and refrigeration rooms and extends to the outside perimeter of the plant. Storage shelves are installed along the interior walls, and the center area is for storing products on portable racks. The shelves next to the entrance to the ice cream processing room are separated by a 5-foot-wide aisle and used for storing frozen ingredients. The remaining shelves are for storing finished products. Aisles, 2½ to 3 feet wide, provide access between the rows of shelves for storing products and assembling route orders. Aisles on each side of the rack storage area and the one along the roller conveyor are 5 and 6 feet wide, respectively, with an 8-foot-wide area next to the entrance of the vestibule to facilitate the movement of racks.

The shelves are three high, 18 inches apart, and 24 inches wide to provide a stacking height of 6 feet. Approximately 4,815 cubic feet of shelf space are available for storing finished products. Assuming that 2½ gallons of product are stored per cubic foot, the total storage capacity of the shelves is approximately 12,037 gallons. Space is provided in the rack storage area for 30 racks 2 wide and 15 long. Based on a storage capacity of 180 gallons per rack, the total storage capacity of the racks is approximately 5,400 gallons. Therefore the total storage capacity of the freezer is about 17,437 gallons, which is more than adequate for storing a 10-day inventory supply of processed products (16,140 gal), as well as the increased volume of frozen novelties (10,500 lb) and the smaller containers of ice cream products purchased from outside sources.

The 23-foot freezer ceiling height provides flexibility for changing the handling and storage methods if necessary. It allows for the installation of a ceiling-mounted quick freeze unit as well as a palletized handling system.

A vestibule, 10 feet wide and 20 feet long, with a 12-foot ceiling height is at the end of the freezer and used to reduce refrigeration losses during loading and unloading. Space is provided for storing empty racks on each side of the center aisle. The outside doorway is for loading and unloading wholesale walk-in type trucks one at a time. Vertical bumpers are installed on the face of the foundation to protect it and the vehicles from possible damage. The floor height is 45 inches to correspond to the average wholesale truckbed height. A bridge plate is used to span the gap between the vestibule floor and truckbeds. The roof is 16 feet above the apron and extends 6 feet at the front and 10 feet on each side for protection during inclement weather. Provision is made on each side of the vestibule for loading reach-in type trucks at ground level. Roller conveyors are used to move the products directly from the freezer to the trucks. The doorways and conveyors for loading these trucks can be eliminated should this method of loading be discontinued as a result of converting to all wholesale-type truck deliveries.

Other Operations

Refrigeration.—The refrigeration room, 35 feet by 35 feet, is next to the ice cream processing room and freezer. This location near the areas of greatest need reduces the installation

and operating costs of the refrigeration system. Space is provided for housing and operating the equipment transferred from the remodeled plant and for installing larger equipment to accommodate future growth. A doorway, 10 feet wide by 10 feet high, provides access for moving equipment in or out of the room.

Heating.—The boiler room, 26 feet wide and 35 feet long, which is between the refrigeration room and the receiving shelter, is near those areas and operations that require the greatest use of its facilities. Space is provided for housing and operating the equipment transferred from the remodeled plant and for the installation of a second boiler to serve as a standby or for future needs. A doorway, 10 feet wide by 10 feet high, provides access for moving equipment in or out of the room.

Auxiliary Areas.—The auxiliary areas are at the front of the plant between the dry and container storage and case storage rooms. They include the laboratory, the plant superintendent's office, the employee locker room and restroom, and the entrance and reception office. The plant superintendent's office is located so that the operations in the processing and filling room and the movement of employees between the welfare and processing areas of the plant can be observed. The office also serves as a central point of control for coordinating plant activities.

LABOR ANALYSIS, INVESTMENT COSTS, AND POTENTIAL BENEFITS

Remodeled Facilities

Present Volume

The total annual labor cost to process and handle the present volume in the existing facilities is $163,453.73 (table 10). This includes 53,652 man-hours of annual labor or 22.92 employees for a total labor cost per gallon of 26.46 cents.

By remodeling the existing facilities, the total annual labor cost is reduced to $140,184.02 for a savings of $23,270. This includes 45,849 man-hours of annual labor or 19.60 employees for a total labor cost per gallon of 23.39 cents. The labor reduction is accomplished by rescheduling job assignments and adopting new operating procedures. The annual labor savings of $23,270 is obtained by making changes in the five operations discussed in detail in the appendix, part I.

Future Volume

The total estimated annual labor cost to process and handle the future volume in remodeled facilities is $179,961.14 (table 11). This includes 58,503 man-hours of annual labor or 24.99 employees for a total labor cost per gallon of 22.15 cents. The $179,961.14 represents a 28.4-percent increase in the total annual labor cost for handling the present volume in remodeled facilities. The 11 operations where changes are made in labor requirements because of increased volume are discussed in detail in the appendix, part II.

The small increase in present labor cost from $163,453.73 to $179,961.14 along with a 50-percent increase in volume represents increased productivity per man-hour of labor and a reduction in unit labor cost to provide a potential annual savings of $65,140. Small savings in other cost categories can be achieved in the remodeled facilities as a result of the increased volume; however, evaluations were not made since the amounts would be rather insignificant. A breakdown of the potential annual labor savings by categories is as follows:

Fluid products	$33,768
Miscellaneous	17,465
Cottage cheese	269
Ice cream	13,638
Total	65,140

The estimated cost of remodeling the existing facilities to handle the future volume is $35,000 and includes the following items:

Estimated Remodeling Cost[1]

Mix vat (1,000 gal)	$7,000
Modification of filler (30 units per minute)	7,500
Installation of filler (45 units per minute)	3,500
Carton conveyor combiner	1,500

TABLE 10.—*Estimated total production labor cost to process and handle present annual volume in existing and remodeled facilities*

Operation	Existing facilities				Remodeled facilities			
	Employees [1]	Labor	Total labor cost	Cost per gallon	Employees [1]	Labor	Total labor cost	Cost per gallon
	Number	*Man-hours*	*Dollars*	*Dollars*	*Number*	*Man-hours*	*Dollars*	*Dollars*
Fluid products: [2]								
Receiving	1.21	2,836	7,878.20	0.0020	1.21	2,836	7,878.20	0.0020
Processing	2.32	5,429	17,247.40	.0044	2.32	5,429	17,247.40	.0044
Filling, casing, and stacking	2.97	6,953	22,266.85	.0057	2.97	6,953	22,266.85	.0057
Handling cases and cans	1.12	2,626	7,254.06	.0019	1.12	2,626	7,254.06	.0019
Cooler storing and shipping	4.73	11,071	31,432.70	.0081	3.29	7,696	21,856.64	.0056
Subtotal	12.35	28,915	86,079.21	.0221	10.91	25,540	76,503.15	.0196
Miscellaneous: [2]								
Receiving supplies	.22	504	1,723.68	.0004	.22	504	1,723.68	.0004
General cleanup	1.88	4,396	12,747.50	.0033	1.32	3,094	8,969.50	.0023
Spare and relief	.92	2,159	8,204.20	.0021	.79	1,845	7,011.00	.0018
Supervisory	.92	2,154	8,852.94	.0023	.79	1,841	7,566.51	.0020
Subtotal	3.94	9,213	31,528.32	.0081	3.12	7,284	25,270.69	.0065
Cottage cheese, [3] processing and packaging	1.58	3,697	10,924.85	.1096	1.58	3,697	10,924.85	.1096
Ice cream: [4]								
Processing and packaging	4.47	10,470	31,189.60	.1115	3.41	7,971	23,753.58	.0849
Freezer storing and shipping	.58	1,357	3,731.75	.0133	.58	1,357	3,731.75	.0133
Subtotal	5.05	11,827	34,921.35	.1248	3.99	9,328	27,485.33	.0982
Grand total	22.92	53,652	163,453.73	.2646	19.60	45,849	140,184.02	.2339

[1] Based on annual average of 2,340 man-hours.
[2] Annual volume – 3,881,540 gal.
[3] Annual volume – 99,710 gal.
[4] Annual volume – 279,760 gal.

TABLE 11.—*Estimated total production labor cost to process and handle future annual volume in remodeled and new facilities*

Operation	Remodeled facilities				New facilities			
	Employees [1]	Labor	Total labor cost	Cost per gallon	Employees [1]	Labor	Total labor cost	Cost per gallon
	Number	*Man-hours*	*Dollars*	*Dollars*	*Number*	*Man-hours*	*Dollars*	*Dollars*
Fluid products: [2]								
Receiving	1.54	3,611	10,031.00	0.0017	1.54	3,611	10,031.00	0.0017
Processing	2.83	6,614	21,012.02	.0036	2.70	6,324	20,090.72	.0034
Filling, casing, and stacking	4.93	11,540	36,928.00	.0063	4.86	11,385	36,432.00	.0062
Handling cases and cans	1.04	2,436	6,723.36	.0012	1.04	2,436	6,723.36	.0012
Cooler storing and shipping	3.05	7,126	20,237.84	.0035	2.06	4,820	13,688.80	.0024
Subtotal	13.39	31,327	94,932.22	.0163	12.20	28,576	86,965.88	.0149
Miscellaneous: [2]								
Receiving supplies	.32	756	2,585.52	.0004	.11	252	861.84	.0001
General cleanup	1.32	3,094	8,969.50	.0015	.83	1,950	5,653.05	.0010
Spare and relief	1.01	2,354	8,945.20	.0015	.86	2,018	7,668.40	.0013
Supervisory	1.00	2,349	9,654.39	.0017	.86	2,013	8,273.43	.0014
Subtotal	3.65	8,553	30,154.61	.0051	2.66	6,233	22,456.72	.0038
Cottage cheese,[3] processing and packaging	2.33	5,459	16,131.35	.1078	2.17	5,078	15,005.49	.1003
Ice cream: [4]								
Processing and packaging	4.72	11,052	32,934.96	.0785	3.64	8,512	25,365.76	.0604
Freezer storing and shipping	.90	2,112	5,808.00	.0138	.75	1,744	4,796.00	.0114
Subtotal	5.62	13,164	38,742.96	.0923	4.39	10,256	30,161.76	.0718
Grand total	24.99	58,503	179,961.14	.2215	21.42	50,143	154,589.85	.1908

[1] Based on annual average of 2,340 man-hours.
[2] Annual volume – 5,822,180 gal.
[3] Annual volume – 149,565 gal.
[4] Annual volume – 419,640 gal.

Cheese vat (1,200 gal)	4,500
Power and gravity roller conveyors	1,000
Construction (relocating walls)	8,000
Miscellaneous	2,000
Total	35,000

[1] Based on 1976 manufacturers' suggested retail price f.o.b. plant, including transportation and installation where applicable.

Most of the remodeling cost involves modification or purchase of new equipment that can be transferred to new facilities. Changes affecting the physical structure of the buildings are held to a minimum, since they become obsolete at the future volume level.

By excluding the net income on additional sales and applying only the potential annual labor savings of $65,140 to the estimated remodeling cost of $35,000, less than a year is needed to satisfy the investment. Remodeling the existing facilities is highly feasible; however, it does not provide growth capability in excess of 50 percent of the present volume.

New Facilities

The total estimated annual labor cost to process and handle the future volume in new facilities is $154,589.85 (table 11). This includes 50,143 man-hours of annual labor or 21.42 employees for a total labor cost per gallon of 19.08 cents. The $154,589.85 represents a 14.1-percent decrease in the total annual labor cost for handling the future volume in remodeled facilities. The 10 operations where changes are made in labor requirements between handling the future volume in remodeled and in new facilities are discussed in detail in the appendix, part III.

The small reduction in present labor cost from $163,453.73 to $154,589.85 along with a 50-percent increase in volume represents increased productivity per man-hour of labor and a reduction in unit labor cost to provide a potential annual savings of approximately $90,585. The opportunities for achieving additional savings in other cost categories as a result of the increased volume are much greater in the new than in the remodeled facilities. However, evaluations were not made nor benefits determined since the savings attainable in other cost categories would be relatively small as compared to the labor savings. A breakdown of the potential annual labor savings by categories is as follows:

Fluid products	$41,918
Miscellaneous	25,037
Cottage cheese	1,390
Ice cream	22,240
Total	90,585

The estimated total initial investment cost of new facilities is approximately $2,589,705 and includes the following:

Estimated Building Cost[1]

Building [2]	*Ft²*	*Cost per square foot*	*Total cost*
Processing plant	25,560	$68	$1,738,080
Offices (second floor)	5,035	28	140,980
Warehouse (rear of site)	2,100	40	84,000
Garage (rear of site)	1,750	35	61,250
Truck washing system (rear of site)	992	35	[3] 34,720
Total	35,437	---	2,059,030

[1] Based on September 1976 building cost in North Central United States and provided by an independent dairy engineering and consulting firm.

[2] Complete and ready for occupancy less movable equipment to be transferred from existing facilities.

[3] Includes $9,000, which represents 1976 manufacturers' suggested retail price f.o.b. plant plus transportation and installation for the washing system.

Estimated Equipment Cost[1]

Mix vat (1,000 gal)	$7,000
Modification of filler (30 units per minute)	7,500
Installation of filler (45 units per minute)	3,500
Carton conveyor combiner	1,500
Cheese vat (1,200 gal)	4,500
Automatic control panel system	100,500
CIP system	24,000
Complete piping and valve system	[2] 90,000
Power conveyor system (515 ft @ $150 per foot)	77,250
Freezer (180 gal per hour)	37,000
Multicompartment tank (3 compartments @ 150 gal each)	10,900
Pallet stacker (3,000-lb capacity)	9,600
Pallets (350 @ $5.50 per pallet)	1,925
Pallet racks (264 slots @ $35 per slot)	9,250
Freezer shelves (4,815 ft³ @ $1.35 per cubic foot)	6,500
Freezer storage racks (30 racks @ $150 per rack)	4,500

Miscellaneous	20,000
Total	415,425

[1] Based on 1976 manufacturers' suggested retail price f.o.b. plant, including transportation and installation where applicable.

[2] Represents investment and installation costs of new equipment not transferred from existing plant.

Estimated Site Cost

5½-acre site	[1] $30,250
Site preparation	[2] 25,000
Total	55,250

[1] Based on September 1976 market value of urban land in North Central United States.

[2] Represents a contracting firm's bid for grading and leveling, landscaping, hard-surfacing site, and installing sewage lines and other utilities.

Estimated Relocation Cost[1]

Transfer and install existing equipment	$40,000
Loss of income during transfer	20,000
Total	60,000

[1] Based on estimates of 2 contracting firms.

The estimated total investment cost of new facilities minus the salvage value of $250,000 [7] for the existing facilities leaves a net cost of approximately $2,339,705. By applying the potential annual labor savings of $90,585 and the net income on additional sales of $160,000 [8] to the net cost of new facilities, the amortization time at 8-percent interest would be approximately 18 years.

CONCLUSIONS

Based on findings in this report, the remodeling of existing facilities is the most practical and economical method of meeting future requirements where the physical condition of the facilities is satisfactory, the location is adequate, and sufficient space is available for expansion. Although maximum operating efficiency cannot always be achieved by remodeling, it is still the preferable method when considering the high cost of building and relocating in new facilities. Many plants are operating with inefficiencies that can be corrected at minimal cost by simply rescheduling operations and labor assignments and implementing improved operating procedures. Others have "built-in" inefficiencies that require more elaborate and costly structural and equipment changes. The remodeled facilities in this report exemplify how these and other problems that contribute to inefficiency can be resolved to make the remodeling of existing facilities economically feasible.

Where existing facilities cannot be remodeled for one or more reasons, the logical alternative for continuing growth is the construction of new facilities. Although the initial cost is extremely high because of increasing land and construction cost, the operating cost is generally lower in properly designed and equipped facilities. New facilities also offer other advantages over remodeling, such as (1) the option of relocating to accommodate for shifts in population growth, (2) greater flexibility for introducing new and future technological developments, and (3) provisions for long-range growth capabilities. Additional benefits achieved by operating in new facilities include simplification of operations, better utilization of floorspace, less congestion, improved product quality, and better employee morale, safety, and supervision. The new facilities in this report provide sufficient benefits to justify their construction; however, a greater volume would further enhance the feasibility. This determination is predicated on a healthy business environment and a continuing stable economy.

[7] Commitment from the city downtown redevelopment authority.

[8] Increase of 2.5 percent of total annual sales represents growth in net income achieved through increased volume as reported in firm's profit and loss statement for 1972 and previous years.

APPENDIX

Part I – Labor Requirements for Handling Present Volume in Remodeled Facilities

The following data show the estimated production labor requirements for those plant operations where changes are made in processing and handling the present volume in remodeled facilities.

Cooler Storing and Shipping

Five employees representing 11,071 man-hours of annual labor are used in the existing facilities to conduct the cooler storing and shipping operation (table 12). The finished products are received in the cooler from the filling areas and from outside sources and stored by product type. When ready for shipping, they are manually selected from inventory using a route load sheet and placed on the conveyor for moving to the loading dock.

In the remodeled facilities, four employees representing 7,696 man-hours of annual labor are needed to conduct the operation. The reduction of 3,375 man-hours of labor is accomplished by assembling the route loads as the finished products are received in the cooler from the filling areas. During this period, those products received from outside sources are selected from inventory to complete the route loads. Additions or changes in the products that make up the route loads are made at the time of loading. By assembling the route loads in advance, the additional time and labor required in selecting and assembling products are eliminated and better labor utilization is achieved. This method also reduces the time trucks are required to wait at the dock while route loads are being assembled.

General Cleanup

The general cleanup operation in the existing facilities utilizes 4,396 man-hours of annual labor (table 13). This includes only facility cleanup time, which is allocated to each plant area on those days when activities are conducted.

In the remodeled facilities, 3,094 man-hours of annual labor are required in the general cleanup operation. A reduction of 1,302 man-hours of labor is made as a result of the ice cream processing and packaging and the freezer storing and shipping operations being converted to a 5-day week and by better scheduling of the cleaning personnel to avoid loss of productive time. Scheduling cleanup time in many widely separated plant areas by a cleaning crew is somewhat difficult to accomplish and conducive to lost time, but it can be minimized by having the other plant operations properly scheduled.

Spare and Relief and Supervisory

The annual reductions in spare and relief and in supervisory labor in the remodeled facilities are in direct proportion to the total man-hours required to conduct the other plant operations. With an average net reduction of 14.54 percent, spare and relief labor is reduced annually from 2,159 to 1,845 man-hours of labor, whereas supervisory is reduced from 2,154 to 1,841 (table 14).

Ice Cream Processing and Packaging

The ice cream processing and packaging operations in the existing facilities utilize 10,470 man-hours of annual labor, whereas 7,971 are required in the remodeled facilities (table 15). This reduction of 2,499 man-hours of labor is made by converting to a 5-day processing week and by eliminating wasted labor through better scheduling and proper job assignments. For example, where three employees are used to close and case containers in the existing facilities, only two are needed in the remodeled facilities.

TABLE 12.—*Comparison of labor requirements in cooler storing and shipping operation in existing and remodeled facilities*

Cooler operator	Existing facilities			Remodeled facilities		
	Functions	Labor per day	Total annual labor	Functions	Labor per day [1]	Total annual labor
		Man-hours	*Man-hours*		*Man-hours*	*Man-hours*
No. 1	Operates stackers; removes products from conveyor and places them in storage	9.60	2,496	Operates stackers; assembles route orders	9.60	2,496
No. 2	Removes products from conveyor and places them in storage; receives miscellaneous products	9.60	2,496	Assembles route orders; places orders on conveyor for loading	9.60	2,496
No. 3	Selects and places products on conveyor for loading; aids drivers in loading trucks	9.60	2,496	Receives miscellaneous products; aids drivers in loading trucks	9.60	2,496
No. 4	Selects and places products on conveyor for loading; aids drivers in loading trucks	9.60	2,496	Aids drivers in loading trucks on nonprocessing days [2]	.80	208
No. 5	Aids drivers in loading trucks on processing and nonprocessing days	4.18	1,087			
Total		42.58	11,071		29.60	7,696

[1] Based on maximum daily filling time.

[2] Represents 4 man-hours of labor on nonprocessing day.

TABLE 13.—*Comparison of labor requirements in general cleanup operation in existing and remodeled facilities*

Plant area	Existing facilities			Remodeled facilities		
	Labor per day	Days per week	Total annual labor	Labor per day [1]	Days per week	Total annual labor
	Man-hours	*Number*	*Man-hours*	*Man-hours*	*Number*	*Man-hours*
Receiving shelter	0.67	7	244	0.50	7	182
Processing and filling room	2.58	6	805	2.00	6	520
Case storage room	1.34	5	348	1.00	5	260
Can washing and storage room	.67	5	174	.50	5	130
Cooler	1.34	6	418	1.00	6	260
Ice cream processing room	1.83	6	571	1.50	5	390
Freezer	.67	6	209	.50	5	130
Cheese processing room	1.83	4	381	1.50	4	312
Container storage room	2.58	5	671	2.00	5	520
Warehouses	2.21	5	575	1.50	5	390
Total	----	--	4,396	----	--	3,094

[1] Based on experiences of similar firms in comparable facilities, including 15-percent allowance for fatigue and personal needs.

TABLE 14.—*Estimated annual labor requirements by operations and reductions in spare and relief and in supervisory labor for present volume in remodeled facilities*

Operation	Labor in existing facilities for present volume	Labor in remodeled facilities for present volume	Reduction in remodeled facilities
	Man-hours	*Man-hours*	*Percent*
Receiving	2,836	2,836	0
Processing	5,429	5,429	0
Filling, casing, and stacking	6,953	6,953	0
Handling cases and cans	2,626	2,626	0
Cooler storing and shipping	11,071	7,696	30.48
Receiving supplies	504	504	0
General cleanup	4,396	3,094	29.62
Cottage cheese processing and packaging	3,697	3,697	0
Ice cream processing and packaging	10,470	7,971	23.87
Freezer storing and shipping	1,357	1,357	0
Average net reduction	-----	-----	14.54
Spare and relief	2,159	1,845	----
Supervisory	2,154	1,841	----
Total	53,652	45,849	14.54

TABLE 15.—*Comparison of labor requirements in ice cream processing and packaging and freezer storing and shipping operations in existing and remodeled facilities*

Function [1]	Existing facilities		Remodeled facilities	
	Labor per day	Total annual labor	Labor per day [2]	Total annual labor
	Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
Processing:				
Set up equipment	2.500	780	2.000	520
Transfer ingredients from storage to processing room	.278	87	.333	87
Transfer mix to flavor tanks and prepare to freeze	3.334	1,040	4.167	1,083
Freeze [3]	3.733	1,165	4.483	1,165
Clean equipment	2.500	780	2.000	520
Packaging:				
Set up equipment	1.000	312	.500	130
Transfer containers from storage to processing room	1.559	486	1.226	319
Form containers	2.055	641	1.500	390
Fill containers (manually)	3.733	1,165	4.483	1,165
Close and case containers	11.368	3,546	8.966	2,332
Clean equipment	1.500	468	1.000	260
Subtotal	33.560	10,470	30.658	7,971
Freezer storing and shipping:				
Receive and store processed products in freezer; assemble orders and load trucks	3.733	1,165	4.483	1,165
Receive and store frozen novelties in freezer [4]	.616	192	.736	192
Subtotal	4.349	1,357	5.219	1,357
Grand total	37.909	11,827	35.877	9,328

[1] Conducted 6 days a week in existing facilities and 5 days in remodeled facilities.
[2] Based on time studies except functions governed by freezing time.
[3] Man-hours based on freezing time at 80-percent efficiency.
[4] Conducted 4 times a month with labor requirement spread over a year.

Part II – Labor Requirements for Handling Future Volume in Remodeled Facilities

The following data show the estimated production labor requirements for those plant operations where changes are made between processing and handling the present and the future volume in remodeled facilities.

Receiving

Total annual labor in the receiving operation is increased from 2,836 to 3,611 man-hours to handle the future volume in remodeled facilities (table 16). This increase of 775 man-hours of labor is attributed to unloading and cleaning the greater number or larger tank trucks needed in delivering the additional volume of raw milk to the plant.

Processing

The annual labor requirements in the processing operation are increased from 5,429 to 6,614 man-hours to handle the future volume in remodeled facilities (table 17). The increase of 1,185 man-hours of labor is required for both high temperature, short time and batch processing the greater volume and for setting up and cleaning the additional batch processing and blending equipment. It also includes the labor for moving a larger volume of supplies from storage to the processing areas.

TABLE 16.—*Comparison of labor requirements in receiving operation for present and future volume in remodeled facilities*

Function	Present volume		Future volume	
	Labor per day	Total annual labor	Labor per day [1]	Total annual labor
	Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
Set up equipment	0.333	121.54	0.333	121.54
Unload product	3.436	1,254.46	4.060	1,481.96
Clean tank trucks	2.000	730.00	3.500	1,277.50
Clean equipment	2.000	730.00	2.000	730.00
Total	7.769	2,836.00	9.893	3,611.00

[1] Based on time studies.

TABLE 17.—*Comparison of labor requirements in processing operation for present and future volume in remodeled facilities*

Function	Present volume			Future volume		
	Processing days per week	Labor per day	Total annual labor	Processing days per week	Labor per day	Total annual labor
	Number	*Man-hours*	*Man-hours*	*Number*	*Man-hours*	*Man-hours*
HTST processing:[1]	5	6.096	1,585.00	5	9.119	2,371.00
Set up equipment	5	1.000	260.00	5	1.000	260.00
Clean equipment	5	2.000	520.00	5	2.000	520.00
Batch processing:[2]	2–6	7.508	1,561.76	2–6	8.067	1,678.05
Set up equipment	2–6	.837	174.10	2–6	1.000	208.00
Clean equipment	2–6	4.832	1,005.06	2–6	5.168	1,074.94
Transfer supplies from storage to point of use:[2]						
Ice cream mix	6	.277	86.42	6	.416	129.79
Soft serve mix	6	.444	138.53	6	.666	207.79
Chocolate milk	5	.222	57.72	5	.333	86.58
Skim milk	2	.222	23.09	3	.333	51.95
Fruit drinks	1	.333	17.32	3	.166	25.90
Total	---	----	5,429.00	---	----	6,614.00

[1] Man-hours based on rated capacity of high temperature, short time processing equipment utilized at 90-percent efficiency.

[2] Man-hours based on time studies.

Filling, Casing, and Stacking

In the filling, casing, and stacking operation, the total annual labor is increased from 6,953 to 11,540 man-hours to handle the future volume in remodeled facilities (table 18). This rather large increase of 4,587 man-hours of labor is required for filling containers, setting up and cleaning the additional fillers and other equipment, and moving a larger volume of packaging material from storage to the filling areas.

Handling Cases and Cans

The annual labor requirements for handling cases and cans are reduced from 2,626 to 2,436 man-hours to handle the future volume in remodeled facilities (table 19). The reduction of 190 man-hours of labor is achieved as a result

TABLE 18.—*Comparison of labor requirements in filling, casing, and stacking operation for present and future volume in remodeled facilities*

Function	Present volume					Future volume				
	Average distance traveled round trip	Trips	Time per trip	Labor per day	Total annual labor	Average distance traveled round trip	Trips	Time per trip	Labor per day	Total annual labor
	Ft	*Number*	*Min*	*Man-hours*	*Man-hours*	*Ft*	*Number*	*Min*	*Man-hours*	*Man-hours*
Fill containers [1]	---	--	---	19.350	5,031.00	---	--	---	33.219	8,637.00
Set up and clean equipment	---	--	---	6.450	1,677.00	---	--	---	9.750	2,535.00
Transfer packaging materials from storage to point of use: [2]										
Paper containers [3]	180	7	4.96	.579	150.54	180	10	5.22	.870	226.20
Plastic bottles and caps [4]	360	3	5.06	.253	65.78	360	4	5.70	.380	98.80
Dispenser boxes and liners [5]	350	2	3.31	.110	28.68	350	2	4.95	.165	43.00
Total	---	--	---	26.742	6,953.00	---	--	---	44.384	11,540.00

[1] Man-hours based on maximum daily filling time of equipment utilized at 80-percent efficiency.
[2] Man-hours based on time studies.
[3] Transferred by chute.
[4] Transferred by pallets.
[5] Transferred by 2-wheel handtrucks.

TABLE 19.—*Comparison of labor requirements in handling cases and cans for present and future volume in remodeled facilities*

Function	Present volume		Future volume	
	Labor per day	Total annual labor	Labor per day	Total annual labor
	Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
Set up and service equipment	0.50	130	0.50	130
Case room operations: [1]				
Keep case conveyors stocked; Wash cans and move them to filling area	9.60	2,496	8.87	2,306
Total	10.10	2,626	9.37	2,436

[1] Man-hours based on maximum daily filling time.

of the changes in filling equipment that reduced the maximum daily filling time of the longest running machine by 50 minutes. This savings is possible since the labor required for handling cases and cans is directly related to maximum filling time.

Cooler Storing and Shipping

In the cooler storing and shipping operation, the total annual labor is reduced from 7,696 to 7,126 man-hours to handle the future volume in remodeled facilities (table 20). The reduction of 570 man-hours of labor is obtained because the maximum daily filling time of the longest running machine is reduced by 50 minutes. Since the labor reduction is based on the maximum daily filling time, it can only be achieved by scheduling the receipt of finished products from outside sources and the loading of trucks during the filling period.

Receiving Supplies

The total annual labor for receiving supplies is increased from 504 to 756 man-hours to handle the future volume in remodeled facilities (table 21). Since no changes are made in the method of receiving supplies, the increase of 252 man-hours of labor is directly related to the additional volume handled.

Spare and Relief and Supervisory

The increases in spare and relief and in supervisory labor to handle the future volume in remodeled facilities are in direct proportion to the total man-hours of annual labor required to conduct the other plant operations. With an average annual net increase of 27.60 percent, spare and relief labor is increased from 1,845 to 2,354 man-hours of labor, whereas supervisory is increased from 1,841 to 2,349 (table 22).

Cottage Cheese Processing and Packaging

In the cottage cheese processing and packaging operation, the total annual labor is increased from 3,697 to 5,459 man-hours to handle the future volume in remodeled facilities (table 23). Even with the facility changes and installation of additional equipment, the increase of 1,762 man-hours of labor is needed to handle the greater volume. The increase is reflected in all functions performed except transferring the cheese dressing, which is eliminated as a result of storing the dressing in the cheese processing room.

Ice Cream Processing and Packaging

In the ice cream processing and packaging operations, the total annual labor is increased

TABLE 20.—*Comparison of labor requirements in cooler storing and shipping operation for present and future volume in remodeled facilities*

Cooler operator	Functions	Present volume		Future volume	
		Labor per day [1]	Total annual labor	Labor per day [1]	Total annual labor
		Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
No. 1	Operates stackers; assembles route orders	9.60	2,496	8.87	2,306
No. 2	Assembles route orders; places orders on conveyor for loading	9.60	2,496	8.87	2,306
No. 3	Receives miscellaneous products; aids drivers in loading trucks	9.60	2,496	8.87	2,306
No. 4	Aids drivers in loading trucks on nonprocessing day [2]	.80	208	.80	208
Total		29.60	7,696	27.41	7,126

[1] Based on maximum daily filling time.

[2] Represents 4 man-hours of labor on nonprocessing day.

TABLE 21.—*Comparison of labor requirements in receiving supplies for present and future volume in remodeled facilities*

Type of supplies [1]	Present volume				Future volume			
	Employees	Labor per day [2]		Total annual labor	Employees	Labor per day [2]		Total annual labor
	Number	*Hr*	*Min*	*Man-hours*	*Number*	*Hr*	*Min*	*Man-hours*
Fluid product paper containers	5	3	0	360	5	4	0	480
Fluid product plastic containers	3	--	30	36	3	1	45	126
Cheese and ice cream packaging materials	3	--	30	36	3	--	45	54
Processing ingredients	3	--	45	54	3	1	0	72
Miscellaneous items	3	--	15	18	3	--	20	24
Total	--	--	--	504	--	--	--	756

[1] All supplies received at plant twice a month.
[2] Based on time studies.

TABLE 22.—*Estimated annual labor requirements by operations and increases in spare and relief and in supervisory labor for future volume in remodeled facilities*

Operation	Labor in remodeled facilities for present volume	Labor in remodeled facilities for future volume	Increase for future volume
	Man-hours	*Man-hours*	*Percent*
Receiving	2,836	3,611	27.33
Processing	5,429	6,614	21.83
Filling, casing, and stacking	6,953	11,540	65.97
Handling cases and cans	2,626	2,436	−7.24
Cooler storing and shipping	7,696	7,126	−7.41
Receiving supplies	504	756	50.00
General cleanup	3,094	3,094	0
Cottage cheese processing and packaging	3,697	5,459	47.66
Ice cream processing and packaging	7,971	11,052	38.65
Freezer storing and shipping	1,357	2,112	55.64
Average net increase	-----	-----	27.60
Spare and relief	1,845	2,354	----
Supervisory	1,841	2,349	----
Total	45,849	58,503	27.60

from 7,971 to 11,052 man-hours to handle the future volume in remodeled facilities (table 24). Even though the filling of small containers from 5-ounce cups through quarts is eliminated in the operation, the increase of 3,081 man-hours of labor is needed to handle the additional volume. The increase is reflected in all functions performed except setting up and cleaning the equipment.

TABLE 23.—*Comparison of labor requirements in cottage cheese processing and packaging operation for present and future volume in remodeled facilities*

Function [1]	Present volume		Future volume	
	Labor per day [2]	Total annual labor	Labor per day [2]	Total annual labor
	Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
Set up equipment	1.250	260	1.750	364
Process	11.019	2,292	16.745	3,483
Package	1.837	382	2.750	572
Clean equipment	1.750	364	2.500	520
Transfer cheese dressing from processing room to cheese room [3]	.250	52	0	0
Transfer supplies from storage to processing room	.500	104	.750	156
Transfer finished products from processing room to cooler	1.168	243	1.750	364
Total	17.774	3,697	26.245	5,459

[1] Conducted 4 days a week.
[2] Based on time studies.
[3] Function eliminated for future volume.

Freezer Storing and Shipping

The annual labor requirements in the freezer storing and shipping operation are increased from 1,357 to 2,112 man-hours to handle the future volume in remodeled facilities (table 24). This increase of 755 man-hours of labor is attributed to the greater volume and based on the additional time required to freeze and fill containers and receive and store frozen novelties.

Part III – Labor Requirements for Handling Future Volume in New Facilities

The following data show the estimated production labor requirements for those plant operations where changes are made between processing and handling the future volume in remodeled and in new facilities.

Processing

The total annual labor in the processing operation is reduced from 6,614 in the remodeled to 6,324 man-hours in the new facilities (table 25). This reduction of 290 man-hours of labor is obtained because of the centralized storage arrangement and improved handling methods, which reduce the moving distances and numbers of trips required in transferring supplies from storage to the processing areas. By having the storage room on the same floor as the processing areas, mechanized equipment can be used to transfer supplies.

Filling, Casing, and Stacking

The annual labor requirements in filling, casing, and stacking are reduced from 11,540 man-hours in the remodeled to 11,385 in the new facilities (table 26). This reduction of 155 man-hours of labor is attributed to the centralized storage arrangement and improved handling methods, which provide shorter moving distances and fewer trips to transfer packaging materials from storage to filling areas. Most of the reduction is due to the handling of paper containers and is achieved by having the storage room on the same floor adjacent to the filling area and by using mechanized equipment to transfer supplies.

TABLE 24.—*Comparison of labor requirements in ice cream processing and packaging and freezer storing and shipping operations for present and future volume in remodeled facilities*

Function	Present volume		Future volume	
	Labor per day [1]	Total annual labor	Labor per day [1]	Total annual labor
	Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
Processing:				
Set up equipment	2.000	520	2.000	520
Transfer ingredients from storage to processing room	.333	87	.500	130
Transfer mix to flavor tanks and prepare to freeze	4.167	1,083	5.465	1,421
Freeze [2]	4.483	1,165	6.739	1,752
Clean equipment	2.000	520	2.000	520
Packaging:				
Set up equipment	.500	130	.500	130
Transfer containers from storage to processing room	1.226	319	1.839	478
Form containers	1.500	390	2.250	585
Fill containers (manually)	4.483	1,165	6.739	1,752
Close and case containers	8.966	2,332	13.477	3,504
Clean equipment	1.000	260	1.000	260
Subtotal	30.658	7,971	42.509	11,052
Freezer storing and shipping:				
Receive and store processed products in freezer; assemble orders and load trucks	4.483	1,165	6.739	1,752
Receive and store frozen novelties in freezer [3]	.736	192	1.383	360
Subtotal	5.219	1,357	8.122	2,112
Grand total	35.877	9,328	50.631	13,164

[1] Based on time studies except functions governed by freezing time.
[2] Man-hours based on freezing time at 80-percent efficiency.
[3] Conducted 4 times a month with labor requirements spread over a year.

Cooler Storing and Shipping

Cooler storing and shipping in the remodeled facilities requires four employees or 7,126 man-hours of annual labor, whereas three employees or 4,820 man-hours are needed in the new facilities (table 27). The reduction of 2,306 man-hours of labor is obtained by having the stackers installed in the filling room rather than in the cooler and by utilizing the labor in this operation to conduct other cooler functions. The labor provided is adequate to conduct all cooler functions because of the improved method of assembling and handling route orders and the design of the cooler, dock, and conveyor system.

Receiving Supplies

The total annual labor for receiving supplies is reduced from 756 in the remodeled to 252 man-hours in the new facilities (table 28). This rather large reduction of 504 man-hours of labor is attributed to the centralized storage arrangement and improved operating procedures. Supplies are handled in palletized form instead of individual packages and moved to storage by mechanized equipment rather than manually.

General Cleanup

The annual labor requirements in the general cleanup operation are reduced from 3,094 man-hours in the remodeled to 1,950 in the new fa-

TABLE 25.—*Comparison of labor requirements in processing operation in remodeled and new facilities*

Function	Processing days per week	Remodeled facilities		New facilities	
		Labor per day	Total annual labor	Labor per day	Total annual labor
	Number	*Man-hours*	*Man-hours*	*Man-hours*	*Man-hours*
HTST processing: [1]					
Set up equipment	5	9.119	2,371.00	9.119	2,371.00
Clean equipment	5	1.000	260.00	1.000	260.00
Batch processing: [2]	5	2.000	520.00	2.000	520.00
Set up equipment	2–6	8.067	1,678.05	8.067	1,678.05
Clean equipment	2–6	1.000	208.00	1.000	208.00
Transfer supplies from storage to point of use: [2]	2–6	5.168	1,074.94	5.168	1,074.94
Ice cream mix	6	.416	129.79	.166	51.81
Soft serve mix	6	.666	207.79	.250	78.00
Chocolate milk	5	.333	86.58	.166	43.20
Skim milk	3	.333	51.95	.166	25.90
Fruit drinks	3	.166	25.90	.084	13.10
Total	---	----	6,614.00	----	6,324.00

[1] Man-hours based on rated capacity of high temperature, short time equipment utilized at 90-percent efficiency.
[2] Man-hours based on time studies in remodeled facilities and method-time measurement procedures in new facilities.

cilities (table 29). This reduction of 1,144 man-hours of labor results from consolidating those plant areas with similar or complementary functions in one centralized location rather than in many widely separated areas and also by proper scheduling of the cleaning personnel.

Spare and Relief and Supervisory

The annual reductions in spare and relief and in supervisory labor in the new facility are in direct proportion to the total man-hours required to conduct the other plant operations. With an average annual net reduction of 14.29 percent, spare and relief labor is reduced from 2,354 to 2,018 man-hours of labor, whereas supervisory is reduced from 2,349 to 2,013 (table 30).

Cottage Cheese Processing and Packaging

In the cottage cheese processing and packaging operation, the total annual labor is reduced from 5,459 in the remodeled to 5,078 man-hours in the new facilities (table 31). The reduction of 381 man-hours of labor is obtained in transferring the supplies from storage to the processing room and the finished products from the processing room to the cooler. The labor savings in transferring supplies is attributed to the centralized storage arrangement, improved handling procedures, and shorter moving distances. By having the storage and processing rooms on the same floor, the supplies can be transferred in palletized form rather than individual packages. The labor savings in transferring finished products is achieved because the processing room is adjacent to the cooler.

Ice Cream Processing and Packaging

In ice cream processing and packaging, the total annual labor is reduced from 11,052 in the remodeled to 8,512 man-hours in the new facilities (table 32). The reduction of 2,540 man-hours of labor is obtained because of the increased freezing capacity, greater number and larger volume of flavor tanks, and the improved facilities. The new facilities are designed to reduce the distance and time required to transfer ingredients and packaging mate-

TABLE 26.—*Comparison of labor requirements in filling, casing, and stacking operation in remodeled and new facilities*

Function	Remodeled facilities					New facilities				
	Average distance traveled round trip	Trips	Time per trip	Labor per day	Total annual labor	Average distance traveled round trip	Trips	Time per trip	Labor per day	Total annual labor
	Ft	*Number*	*Min*	*Man-hours*	*Man-hours*	*Ft*	*Number*	*Min*	*Man-hours*	*Man-hours*
Fill containers [1]	---	--	---	33.219	8,637.00	---	--	---	33.219	8,637.00
Set up and clean equipment	---	--	---	9.750	2,535.00	---	--	---	9.750	2,535.00
Transfer packaging materials from storage to point of use: [2]										
Paper containers (133 cases) [3]	180	10	5.22	.870	226.20	185	5	4.60	.383	99.58
Plastic bottles and caps (53 bags) [4]	360	4	5.70	.380	98.80	230	4	4.63	.309	80.34
Dispenser boxes and liners (8 bundles and 1 case) [5]	350	2	4.95	.165	43.00	320	2	3.82	.127	33.08
Total	---	--	---	44.384	11,540.00	---	--	---	43.788	11,385.00

[1] Man-hours based on maximum daily filling time of equipment utilized at 80-percent efficiency.
[2] Man-hours based on time studies in remodeled facilities and method-time measurement procedures in new facilities.
[3] Transferred by chute in remodeled facilities and by pallets in new facilities.
[4] Transferred by pallets in both facilities.
[5] Transferred by 2-wheel handtrucks in both facilities.

rials from storage and the prepared mix from the processing area into the freezing and packaging room. Transferring the mix to the flavor tanks and preparing to freeze it represents the largest savings and is achieved because the mix is processed in the adjoining room and prepared less frequently and in larger volumes for freezing.

Freezer Storing and Shipping

The annual labor requirements in freezer storing and shipping are reduced from 2,112 man-hours in the remodeled to 1,744 in the new facilities (table 32). Of the total reduction of 368 man-hours of labor, 296 are obtained in receiving and storing processed products in the freezer and assembling orders and loading trucks. Since this savings is based on the time required to freeze and fill containers, it is necessary to schedule the loading of trucks while the products are being processed. The remaining labor savings of 72 man-hours is obtained in receiving and storing frozen novelties and is attributed to the improved facilities and handling system.

TABLE 27.—*Comparison of labor requirements in cooler storing and shipping operation in remodeled and new facilities*

Cooler operator	Functions	Remodeled facilities		New facilities	
		Labor per day [1]	Total annual labor	Labor per day [1]	Total annual labor
		Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
No. 1	Operates stackers; assembles route orders [2]	8.87	2,306	8.87	2,306
No. 2	Assembles route orders; places orders on conveyor for loading	8.87	2,306	8.87	2,306
No. 3	Receives miscellaneous products; aids drivers in loading trucks	8.87	2,306	----	----
No. 4	Aids drivers in loading trucks on nonprocessing day [3]	.80	208	.80	208
Total		27.41	7,126	18.54	4,820

[1] Based on maximum daily filling time.
[2] Functions eliminated in new facilities and replaced by functions performed by operator 3.
[3] Represents 4 man-hours of labor on nonprocessing day.

TABLE 28.—*Comparison of labor requirements in receiving supplies in remodeled and new facilities*

Type of supplies [1]	Remodeled facilities				New facilities			
	Employees	Labor per day [2]		Total annual labor	Employees	Labor per day [2]		Total annual labor
	Number	*Hr*	*Min*	*Man-hours*	*Number*	*Hr*	*Min*	*Man-hours*
Fluid product paper containers	5	4	0	480	2	1	45	84
Fluid product plastic containers	3	1	45	126	2	2	0	96
Cheese and ice cream packaging materials	3	--	45	54	2	--	40	32
Processing ingredients	3	1	0	72	2	--	30	24
Miscellaneous items	3	--	20	24	2	--	20	16
Total	--	--	--	756	--	--	--	252

[1] All supplies received at plant twice a month.
[2] Based on time studies in remodeled facilities and method-time measurement procedures in new facilities.

TABLE 29.—*Comparison of labor requirements in general cleanup operation in remodeled and new facilities*

Plant area	Remodeled facilities			New facilities		
	Labor per day [1]	Days per week	Total annual labor	Labor per day [1]	Days per week	Total annual labor
	Man-hours	*Number*	*Man-hours*	*Man-hours*	*Number*	*Man-hours*
Receiving shelter	0.50	7	182	0.50	7	182
Processing and filling room	2.00	6	520	2.00	6	520
Case storage room	1.00	5	260	.50	5	130
Can washing and storage room [2]	.50	5	130	---	--	----
Cooler	1.00	6	260	1.00	6	260
Ice cream processing room	1.50	5	390	1.00	5	260
Freezer	.50	5	130	.50	5	130
Cheese processing room	1.50	4	312	1.00	4	208
Container storage rooms [3]	2.00	5	520	.50	5	130
Warehouses [4]	1.50	5	390	.50	5	130
Total	---	--	3,094	---	--	1,950

[1] Based on experiences of similar firms in comparable facilities, including 15-percent allowance for fatigue and personal needs.

[2] Space included in case storage room in new facilities.

[3] 4 separate rooms used in remodeled facilities as compared with 1 in new facilities.

[4] Space located in 3 separate warehouses in remodeled facilities as compared with 1 in new facilities.

TABLE 30.—*Estimated annual labor requirements by operations and reductions in spare ana relief and in supervisory labor for future volume in new facilities*

Operation	Labor in remodeled facilities for future volume	Labor in new facilities for future volume	Reduction in new facilities
	Man-hours	*Man-hours*	*Percent*
Receiving	3,611	3,611	0
Processing	6,614	6,324	4.38
Filling, casing, and stacking	11,540	11,385	1.34
Handling cases and cans	2,436	2,436	0
Cooler storing and shipping	7,126	4,820	32.36
Receiving supplies	756	252	66.67
General cleanup	3,094	1,950	36.97
Cottage cheese processing and packaging	5,459	5,078	6.98
Ice cream processing and packaging	11,052	8,512	22.98
Freezer storing and shipping	2,112	1,744	17.42
Average net reduction	-----	-----	14.29
Spare and relief	2,354	2,018	----
Supervisory	2,349	2,013	----
Total	58,503	50,143	14.29

TABLE 31.—*Comparison of labor requirements in cottage cheese processing and packaging operation in remodeled and new facilities*

Function [1]	Remodeled facilities		New facilities	
	Labor per day [2]	Total annual labor	Labor per day [2]	Total annual labor
	Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
Set up equipment	1.750	364	1.750	364
Process	16.745	3,483	16.745	3,483
Package	2.750	572	2.750	572
Clean equipment	2.500	520	2.500	520
Transfer cheese dressing from processing room to cheese room [3]	0	0	0	0
Transfer supplies from storage to processing room	.750	156	.250	52
Transfer finished products from processing room to cooler	1.750	364	.420	87
Total	26.245	5,459	24.415	5,078

[1] Conducted 4 days a week.

[2] Based on time studies in remodeled facilities and method-time measurement procedures in new facilities.

[3] Function eliminated.

TABLE 32.—*Comparison of labor requirements in ice cream processing and packaging and freezer storing and shipping operations in remodeled and new facilities*

Function	Remodeled facilities		New facilities	
	Labor per day [1]	Total annual labor	Labor per day [1]	Total annual labor
	Man-hours	*Man-hours*	*Man-hours*	*Man-hours*
Processing:				
Set up equipment	2.000	520	2.000	520
Transfer ingredients from storage to processing room	.500	130	.166	43
Transfer mix to flavor tanks and prepare to freeze	5.465	1,421	2.173	565
Freeze [2]	6.739	1,752	5.600	1,456
Clean equipment	2.000	520	2.000	520
Packaging:				
Set up equipment	.500	130	.500	130
Transfer containers from storage to processing room	1.839	478	.250	65
Form containers	2.250	585	2.250	585
Fill containers (manually)	6.739	1,752	5.600	1,456
Close and case containers	13.477	3,504	11.200	2,912
Clean equipment	1.000	260	1.000	260
Subtotal	42.509	11,052	32.739	8,512
Freezer storing and shipping:				
Receive and store processed products in freezer; assemble orders and load trucks	6.739	1,752	5.600	1,456
Receive and store frozen novelties in freezer [3]	1.383	360	1.107	288
Subtotal	8.122	2,112	6.707	1,744
Grand total	50.631	13,164	39.446	10,256

[1] Based on time studies and method-time measurement procedures except functions governed by freezing time.
[2] Man-hours based on freezing time at 80-percent efficiency.
[3] Conducted 4 times a month with labor requirements spread over a year.

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